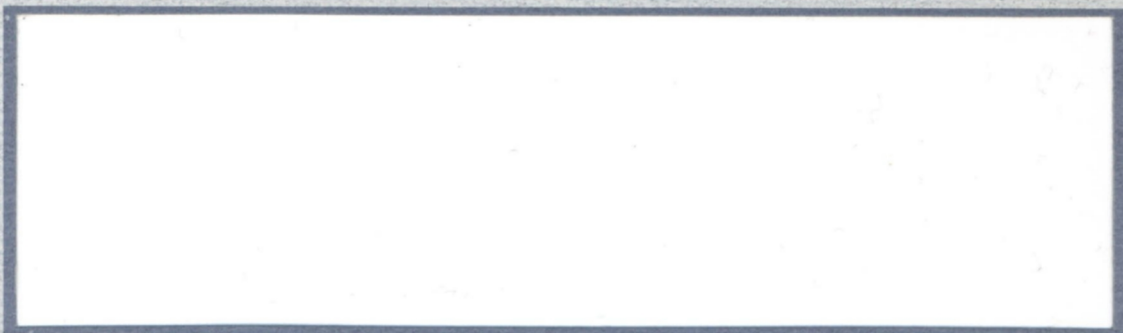


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Final Groundwater Monitoring Plan
Phase II Remedial Design/Remedial Action
Colbert Landfill
Spokane, Washington

8/7/92

August 7, 1992

Prepared for
Spokane County, Washington

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1.0 INTRODUCTION

This document presents the Final Phase II Groundwater Monitoring Plan (Plan) for the Colbert Landfill Remedial Design/Remedial Action Superfund Project (Project). The primary purpose of the Phase II groundwater monitoring system is to provide compliance monitoring for the Phase II South and West Interception Systems. Additionally, data collected during Phase II well construction will supplement Phase I hydrogeologic data and further the understanding of site hydrogeologic conditions.

Phase II groundwater monitoring requirements are specified in Section V of the Project Consent Decree Scope of Work (U.S. District Court 1988). This Plan provides a description of the Project background and existing site conditions; the design for the Phase II groundwater monitoring system (Monitoring System); procedures for Phase II monitoring well construction; methods for groundwater sampling; procedures for equipment decontamination; and disposal practices for soil cuttings and excess groundwater. Post-construction compliance monitoring procedures will be presented in the Project operations and maintenance manual, which will be submitted concurrently with the Phase II plans and specifications.

This Plan was prepared by Landau Associates, Inc. (Landau Associates), Spokane County's engineering consultant for the Project. It is being submitted as part of the 60 percent design of the Phase II Remedial Action and constitutes 90 percent design of the Phase II groundwater monitoring system. Because well construction is dependent on site-specific conditions that cannot be assessed prior to boring advancement, final design (100 percent) will not be performed prior to construction. Instead, as-built well construction diagrams will be submitted to the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) subsequent to construction and will constitute 100 percent design.

1.1 PROJECT BACKGROUND

The Colbert Landfill (Landfill) is an inactive 40-acre municipal solid waste landfill located approximately 15 miles north-northeast of Spokane, WA, and 2.5 miles north of Colbert, WA, as shown on the Regional Location Map (Figure 1-1). The Landfill operated from 1968 until 1986, when it became filled to capacity with municipal and commercial waste.

Groundwater in the vicinity of the Landfill is contaminated with chlorinated organic solvents. At least part of this contamination has been traced to spent solvents that were

disposed of at the Landfill. Solvents were reportedly disposed of at an average rate of several hundred gallons per month for a number of years, and primarily consisted of 1,1,1-trichloroethane (TCA) and methylene chloride (MC). Other organic solvents were also detected in groundwater near the Landfill, including trichloroethylene (TCE), tetrachloroethylene (PCE), 1,1-dichloroethylene (DCE), and 1,1-dichloroethane (DCA). These six chlorinated organic solvents are referred to as the "Constituents of Concern."

In 1980, nearby residents complained to the Eastern Regional Office of Ecology about disposal practices at the Landfill. State and county officials, led by the Spokane County Utilities Department, initiated an investigation into complaints of groundwater contamination in the area by sampling nearby private wells. The results of this initial investigation indicated that some of these wells were contaminated with TCA. In August 1983, EPA placed the Colbert Landfill on its National Priorities List (NPL).

Several studies of the Landfill were conducted since 1980, including the 1987 Remedial Investigation/Feasibility Study (RI/FS; Golder Associates 1987a,b). The purpose of the RI/FS was to determine the nature and extent of contamination caused by the release of chemicals from the Landfill and to evaluate potential remedies. The RI determined that the two primary aquifers in the Landfill vicinity (the Upper and Lower Sand/Gravel Aquifers), and a low-productivity aquifer to the east of the Landfill (Weathered Latah/Basalt Aquifer) are contaminated with some or all of the Constituents of Concern. The FS recommended a pump and treat remedy to address this groundwater contamination.

EPA released its Colbert Landfill Record of Decision (ROD) for public comment in September 1987 (EPA 1987). The remedial action site (Site) is defined in the ROD as the area of potential impact surrounding and including the Landfill, as shown on Figure 1-1. Based on recommendations in the FS, the ROD provides for a performance-based remedial action, consisting of a groundwater pump and treat system. Project performance criteria for the Constituents of Concern are presented in the ROD (Performance Standards), and are shown in Table 1-1. These Performance Standards establish the level of treatment for extracted groundwater and define the maximum constituent concentrations that must be achieved for completion of the remedial action.

Although some flexibility is allowed in the remedial approach, the remedial action specified in the ROD provides for a groundwater extraction system, a treatment system, and a discharge system. The ROD subdivides the extraction system into the following three pumping systems:

- The South Interception System, which will consist of a series of extraction wells installed to intercept the contaminant plume in the Upper Sand/Gravel Aquifer south of the Landfill
- The West Interception System, which will consist of a series of extraction wells installed to intercept the contaminant plume in the Lower Sand/Gravel Aquifer west of the Landfill
- The East Extraction System, which will consist of extraction wells installed in the Lower Sand/Gravel and Latah/Basalt Aquifers near the Landfill for source control (because the East Extraction System is intended for source control, it is not subject to performance monitoring).

The ROD specifies that extracted groundwater will be treated using air stripping to reduce Constituents of Concern in groundwater to the Performance Standards. ROD-specified discharge options for treated water include the Little Spokane River, Deep Creek, and subsurface infiltration.

Subsequent to implementation of the ROD, a Consent Decree for the Colbert Landfill (U.S. District Court 1988) was negotiated between the EPA and Ecology (government plaintiffs), and Spokane County and Key Tronic Corporation (potentially responsible parties). By this action, the County agreed to implement the EPA-selected pump and treat remedy in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) requirements and the State of Washington Hazardous Waste Cleanup Act, codified as Chapter 70.105B RCW.

A scope of work (SOW) to address groundwater contamination emanating from the Landfill is presented in Appendix B of the Consent Decree (U.S. District Court 1988). The SOW specifies the bases for design, design criteria, and criteria for adjustment and modification of the pump and treat system if the performance criteria are exceeded during operation of the remedial action. Because of the difficulties in accurately quantifying MC and DCE at their Performance Standard concentrations, alternative criteria (Evaluation Criteria) are developed in the SOW for assessing performance of Project interception, treatment, and discharge systems, and are presented in Table 1-1.

It was recognized during development of the Consent Decree that available data were inadequate to design the selected remedial action. Consequently, the Project is being implemented in phases. Phase I activities were completed in 1991 and included a number of activities. Thirty groundwater monitoring wells were constructed at 19 locations for additional hydrogeologic and contaminant distribution characterization. Four pilot extraction wells were constructed for aquifer performance (pumping) tests and as source wells for groundwater

treatability studies. A pilot air stripping tower was constructed to treat extracted groundwater from pumping tests and for groundwater treatability studies. A discharge system, including piping and outfalls, was constructed to convey water from the pilot extraction wells to the pilot treatment facility and from the treatment facility to the effluent discharge locations. An onsite meteorological station was also constructed to collect meteorological data. The locations of groundwater monitoring wells and pilot extraction wells constructed during Phase I are shown on Figure 1-2.

Phase I activities were completed in July 1991, and Phase I results are provided in the Phase I Engineering Report (Landau Associates 1991). A conceptual design for the Phase II Interception/Extraction, Treatment, and Discharge Systems similar to that presented in the Phase I Engineering Report is shown on Figure 1-3.

Phase II design, including the Monitoring System design presented in this Plan, are largely based on the results of Phase I.

1.2 SITE CONDITIONS

The Landfill is located on a plateau that is bounded on the west by a steep slope descending toward the Little Spokane River and on the east by low granite and basalt hills. Surface drainage is to the west, towards the Little Spokane River. The climate is characteristic of eastern Washington, with temperatures ranging from typical average summer highs of 83°F to average winter lows of 23°F. The relatively low annual precipitation of approximately 17 inches falls mainly during the winter months of November through February (NOAA 1985).

1.2.1 Hydrogeologic Conditions

The geology of the Landfill area consists of a series of glacially and fluvially derived materials deposited on an eroded landscape of clays, basaltic lava flows, and granitic bedrock. The primary stratigraphic units (layers), from youngest to oldest (i.e., from the top down), are:

- Unit A. Upper Sand/Gravel Unit
- Unit B. Lacustrine Unit
- Unit C. Lower Sand/Gravel Unit
- Unit D₁. Weathered Latah Subunit
- Unit D. Latah Formation
- Unit E. Basalt Unit
- Unit F. Granite Unit.

A generalized east-west profile of these units, based on Phase I data, is shown on Figure 1-4. Figures ER-4.2 through ER-4.9 of the Phase I Engineering Report (Landau Associates 1991) provide more detailed geologic cross sections of the Landfill vicinity.

The hydrogeologic system in the Landfill vicinity is characterized in the Phase I Engineering Report (Landau Associates 1991) as containing four aquifers (two primary and two secondary) and three aquitards:

- The Upper Sand/Gravel Unit (Unit A) forms the Upper Sand/Gravel Aquifer when underlain by the Lacustrine Unit (Unit B), and is considered a primary aquifer.
- The Lacustrine Unit (Unit B) is the low-permeability unit that separates the Upper and Lower Sand/Gravel Units and is referred to as the Lacustrine Aquitard. The Lacustrine Aquitard contains water-bearing sand layers and, based on water elevation data, some of the shallow sand layers appear to be in direct hydraulic connection with the Upper Sand/Gravel Aquifer.
- The Lower Sand/Gravel Unit (Unit C) forms the Lower Sand/Gravel Aquifer, which is the second primary aquifer, and the regional aquifer for the Site.
- The Latah Formation (Unit D), and the Weathered Latah Subunit (Unit D₁), serve as the aquitard underlying the Lower Sand/Gravel Aquifer at most locations and (in combination) are referred to as the Latah Aquitard. However, some low-yield private wells are installed in the Latah Aquitard to the east of the Landfill, where the Upper and Lower Sand/Gravel Aquifers are not present.
- The Basalt Unit (Unit E) forms a secondary aquifer interbedded with the Latah Aquitard, and is referred to as the Basalt Aquifer.
- The Granite Unit (Unit F) serves as the lower boundary (aquitard) to the regional flow system, although some low-productivity wells are installed in the upper portion of this unit.
- The Fluvial Unit associated with the Little Spokane River forms the Fluvial (secondary) Aquifer. The Fluvial Aquifer may be in direct hydraulic connection with the Lower Sand/Gravel Aquifer, but piezometric data suggest that it be treated as an independent unit for hydrogeologic purposes [as discussed in the Phase I Engineering Report (Landau Associates 1992)]. However, the Fluvial Aquifer receives recharge from the Upper Sand/Gravel Aquifer, and is combined with that unit (as the Upper Aquifers) for characterization of constituent distribution (Section 1.2.2).

Units C, D, E, and F are collectively referred to as the "Lower Aquifers" for evaluating regional groundwater flow and contaminant distribution, although the Lower Sand/Gravel Aquifer (Unit C) appears to be the only one of these units capable of sustained yield at high discharge rates.

The Upper Sand/Gravel Aquifer is unconfined, with a depth to water about 90 ft below ground surface in the Landfill vicinity. The thickness of the Upper Sand/Gravel Aquifer varies from about 8-20 ft along its north-south trending centerline, and decreases as it extends toward the western bluff and eastern hills. Upper Sand/Gravel Aquifer groundwater flow is predominantly toward the south with velocities ranging from 5-7 ft/day (Landau Associates 1991). A groundwater elevation contour map for the Upper Sand/Gravel Aquifer is shown on Figure 1-5.

The Lower Sand/Gravel Aquifer is generally confined west of the Landfill and unconfined from the west Landfill boundary to the east. The potentiometric surface of the Lower Sand/Gravel Aquifer is about 180 ft below ground surface, and saturated thickness varies from 0 ft east of the Landfill to over 200 ft near U.S. Highway 2. Groundwater in the Lower Sand/Gravel Aquifer flows predominantly towards the west at velocities ranging from 0.3 to 0.6 ft/day (Landau Associates 1991). However, a lobe of low permeability Latah Aquitard extends to the west into the Lower Sand/Gravel Aquifer. This lobe forms an east-west trending groundwater divide beneath the Landfill, and causes constituents that enter the Lower Sand/Gravel Aquifer from the Landfill vicinity to migrate in separate (northern and southern) flow regimes.

East of the Lower Sand/Gravel Aquifer, groundwater flow occurs primarily as perched groundwater at the Lower Sand/Gravel Unit interface with the underlying Latah Aquitard and within the Basalt (secondary) Aquifer, although some domestic wells are screened within the Latah and Granite Aquitards. Pumping test data and other hydrogeologic information indicate that groundwater extraction east of the Lower Sand/Gravel Aquifer is impracticable because of limited aquifer yield, and may exacerbate the spread of contamination in this area (Landau Associates 1991). A groundwater elevation contour map for the combined Lower Aquifers is shown on Figure 1-6.

A number of hydrogeologic boundary conditions converge in the immediate vicinity of the Landfill:

- The Lacustrine Aquitard pinches out, eliminating the hydraulic separation between the Upper and Lower Sand/Gravel Aquifers
- The Lower Sand/Gravel Unit transitions from unsaturated (to the east) to the primary regional aquifer (to the west)
- A lobe of the Latah Aquitard extends (westerly) into the Lower Sand/Gravel Aquifer, creating an east/west trending groundwater divide near the south edge of the Landfill.

These converging boundary conditions control migration of groundwater (and contaminants) from the Landfill vicinity into, and within, the Lower Aquifers. Groundwater (from beneath the Landfill) enters the unsaturated Lower Sand/Gravel Unit either by lateral flow over the eastern edge of the Lacustrine Aquitard or by direct infiltration through discontinuities in the Lacustrine Aquitard. Groundwater migrates vertically within the Lower Sand/Gravel Unit until contacting the upper surface of the Latah Aquitard. Groundwater then flows (as perched groundwater) along the Lower Sand/Gravel Unit and Latah Aquitard contact until it enters the Lower Sand/Gravel Aquifer (Northern or Southern) Flow Regime. A conceptual model of these groundwater flow characteristics is shown on Figure 1-7.

Sections 4.1 and 4.2 of the Phase I Engineering Report (Landau Associates 1991) should be reviewed for a more thorough discussion of Project hydrogeologic conditions.

1.2.2 Constituent Distribution

The Upper Sand/Gravel Aquifer, Fluvial Aquifer, and shallow sand interbeds of the Lacustrine Aquitard are collectively referred to as the Upper Aquifers for assessing the distribution of Constituents of Concern in groundwater. The Lower Sand/Gravel Aquifer, Basalt Aquifer, Latah Aquitard, and Granite Aquitard are similarly referred to as the Lower Aquifers for constituent distribution evaluation. Figures 1-8 and 1-9 show the distribution of the Constituents of Concern for the Upper and Lower Aquifers, respectively. These figures are based on a composite of groundwater quality data collected through 1991, and represent the areal extent over which one or more of the Constituents of Concern were detected and the area over which one or more of the Constituents of Concern exceed the Performance Standards.

Section 4.3 of the Phase I Engineering Report (Landau Associates 1991) should be reviewed for a more thorough discussion of Project water quality conditions.

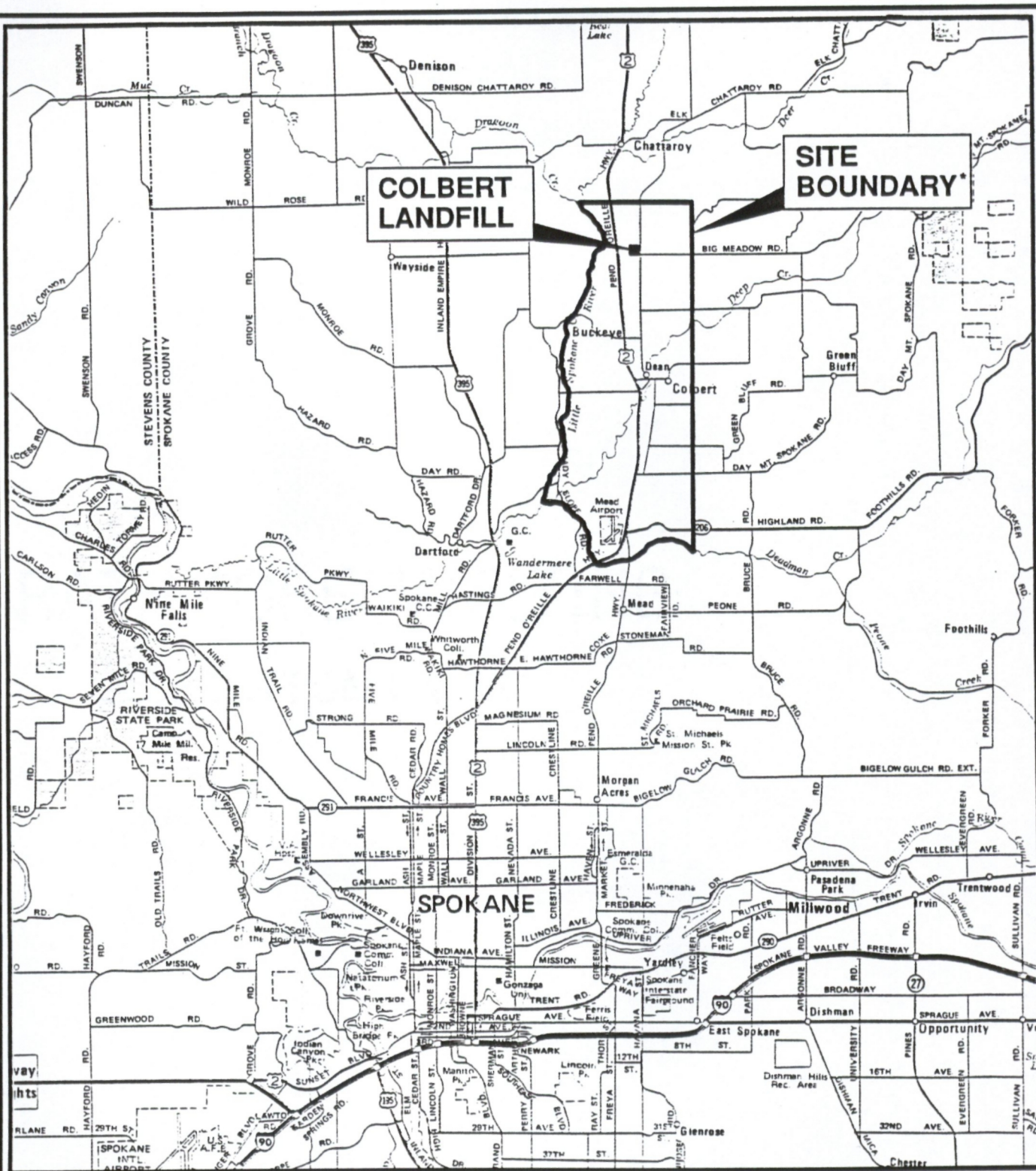
1.3 PROJECT OBJECTIVES

The Project objectives are to: 1) implement aquifer performance and treatability studies to develop design parameters for the final (Phase II) remedial action; 2) perform supplemental characterization (to the RI) of hydrogeologic conditions and the extent of groundwater contamination in the vicinity of the South, West, and East Interception/Extraction Systems; 3) design the final remedial action; and 4) construct the final remedial action, and operate the system until the requirements of the Consent Decree are fulfilled.

Objectives 1 and 2 were achieved during Phase I, as documented in the Phase I Engineering Report (Landau Associates 1991). Objective 3 is being implemented and will be documented in Phase II work plans and in the plans and specifications. Phase II 30 percent design was presented in the preliminary Phase II work plans, the Preliminary Groundwater Monitoring Plan, the Preliminary Extraction Well Plan, and the Preliminary Treatment and Discharge Plan. Sixty percent design is being presented in this and the other final Phase II work plans. Ninety percent and 100 percent design will be submitted as preliminary and final plans and specifications, respectively. Objective 4 will be achieved following EPA and Ecology approval of the Phase II design documents.

1.4 PHASE II DESIGN SCHEDULE

The Phase II design process is anticipated to require about 15 months. The estimated Phase II design schedule is shown on Figure 1-10. Several EPA and Ecology design reviews are incorporated into Phase II design, and the actual time required for design is dependent on timely EPA and Ecology review. The estimated submittal dates shown on Figure 1-10 are subject to modification if EPA and Ecology review comments and approvals are not provided within the indicated period.

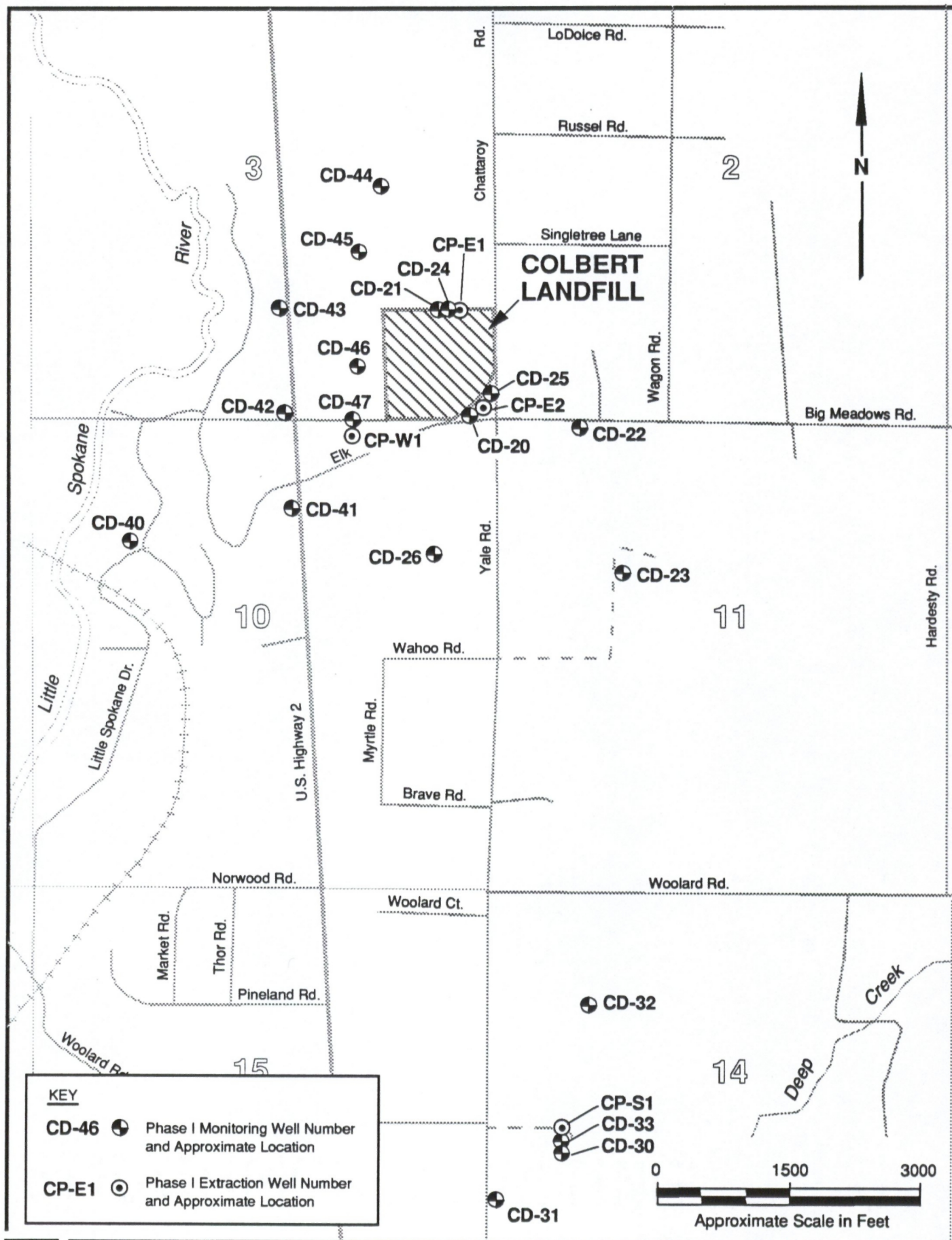


* As specified in the ROD (EPA 1987)



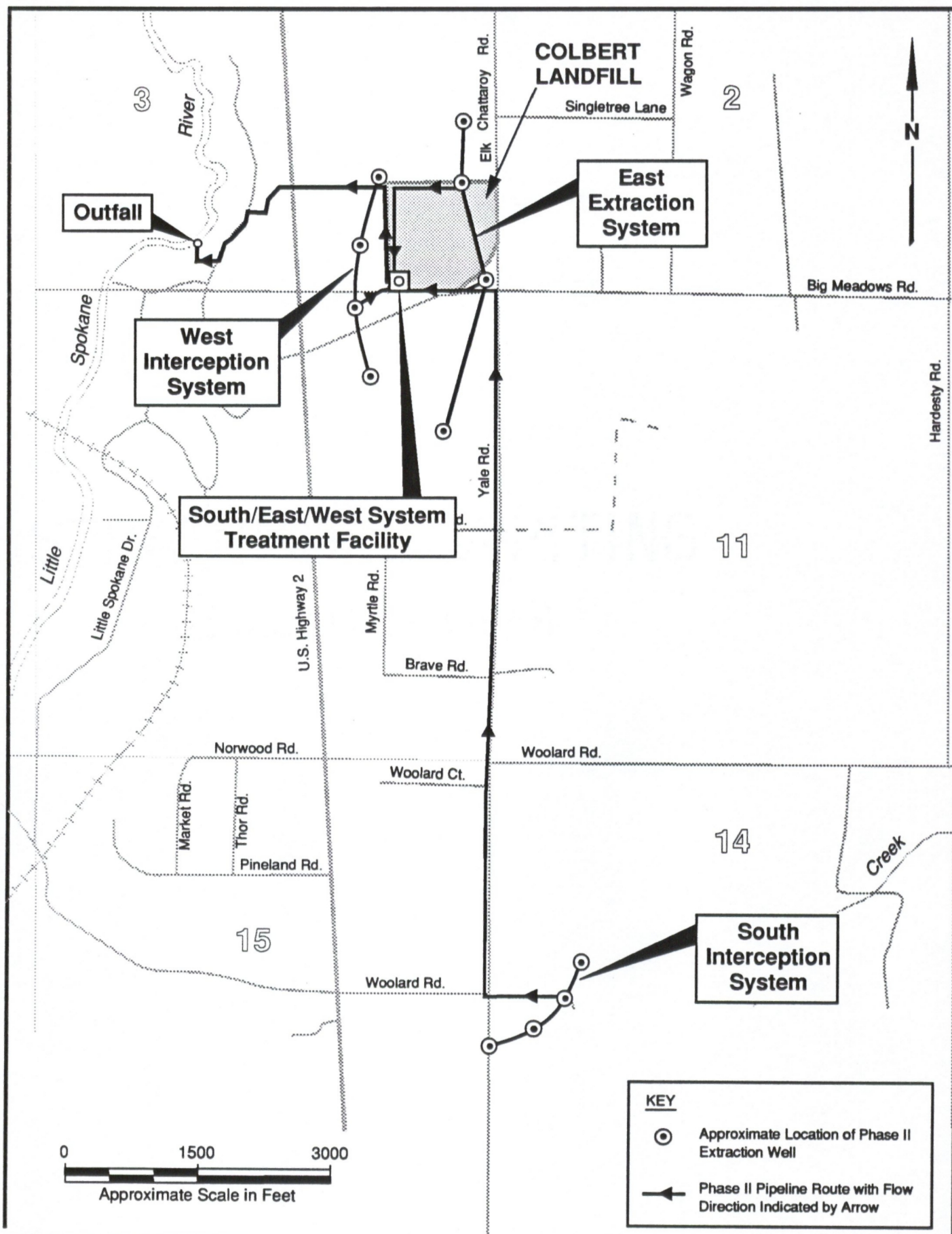
Regional Location Map

Figure 1-1



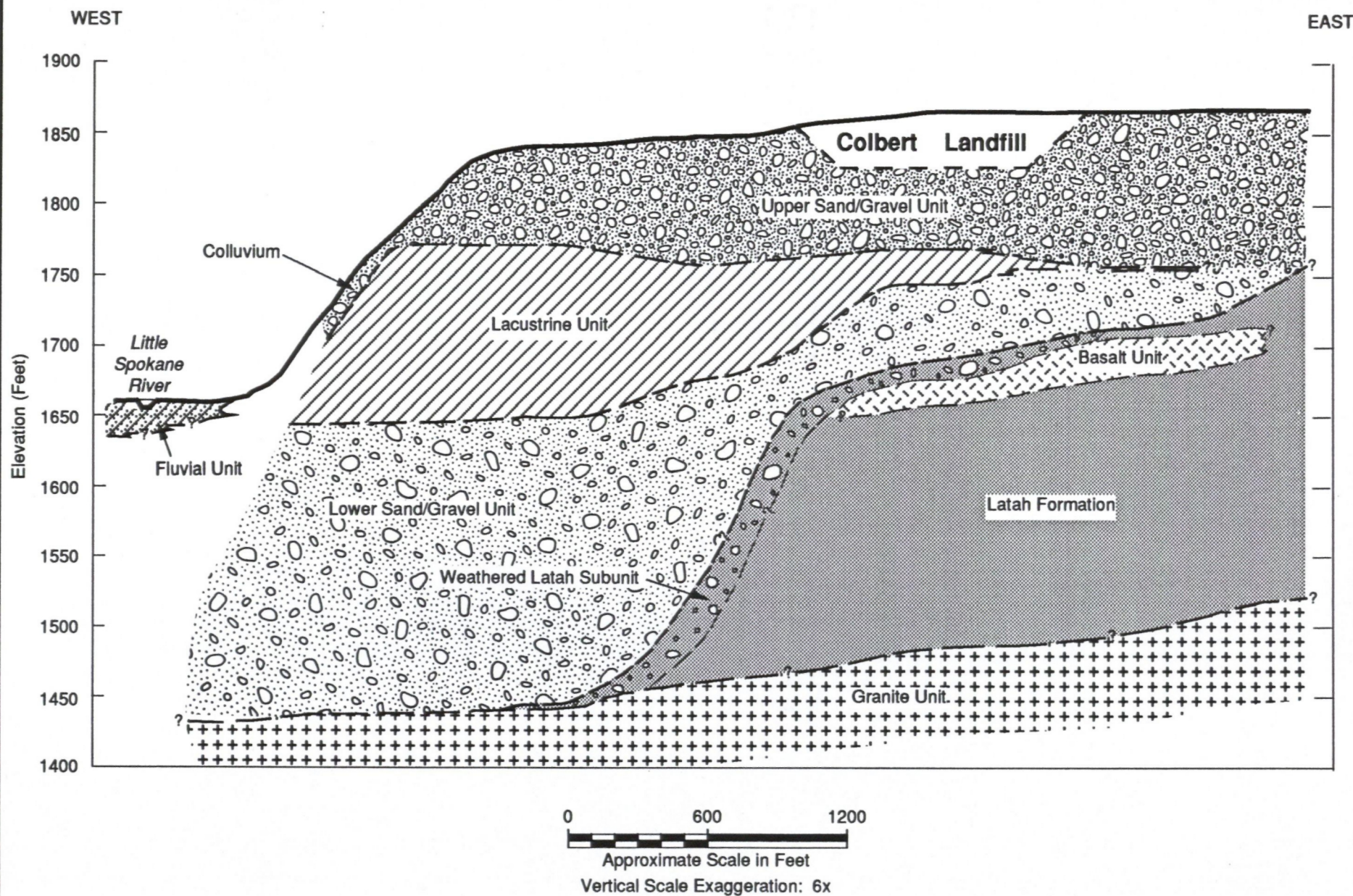
Location of Phase I Monitoring and Extraction Wells

Figure 1-2



Phase II Conceptual Design

Figure 1-3



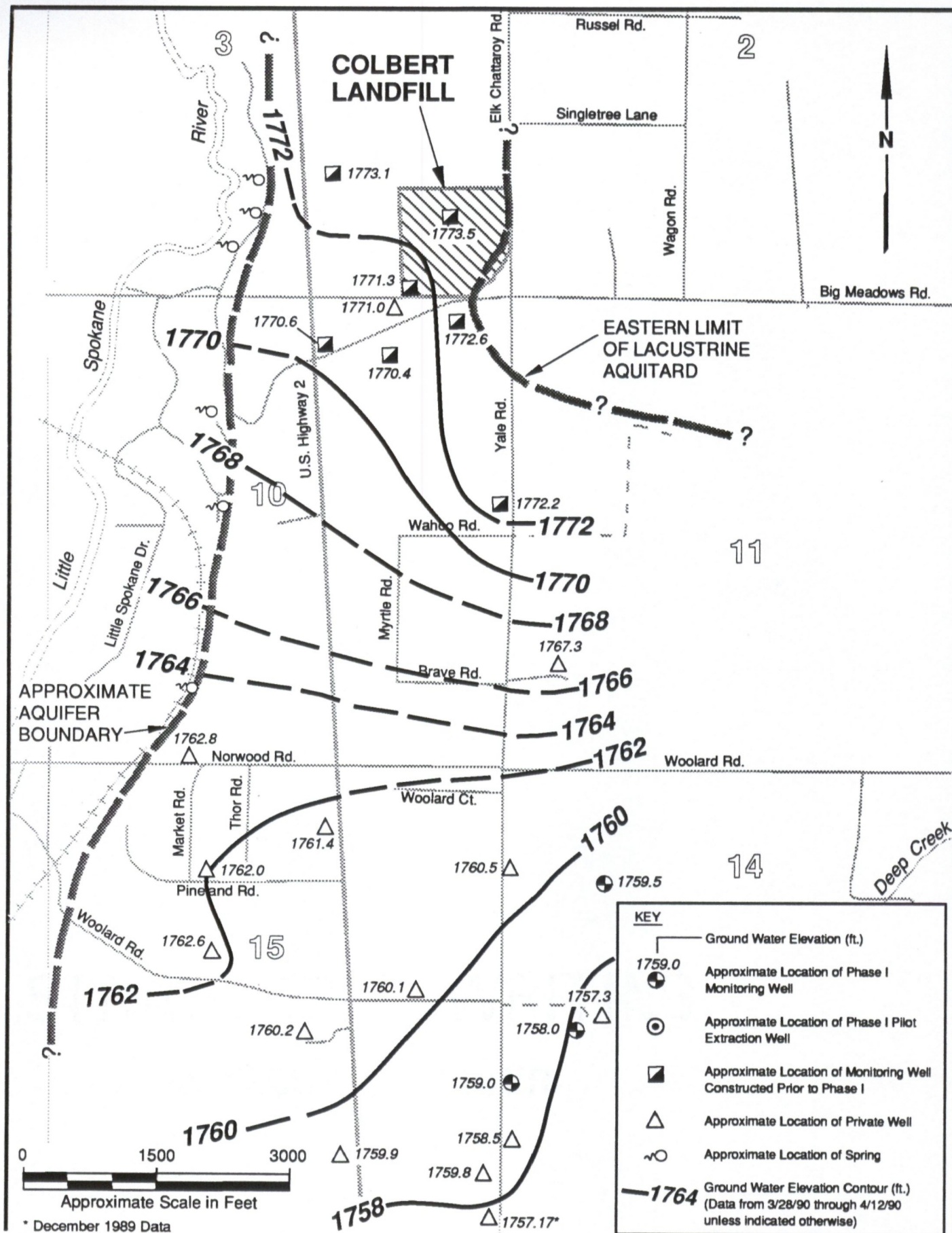
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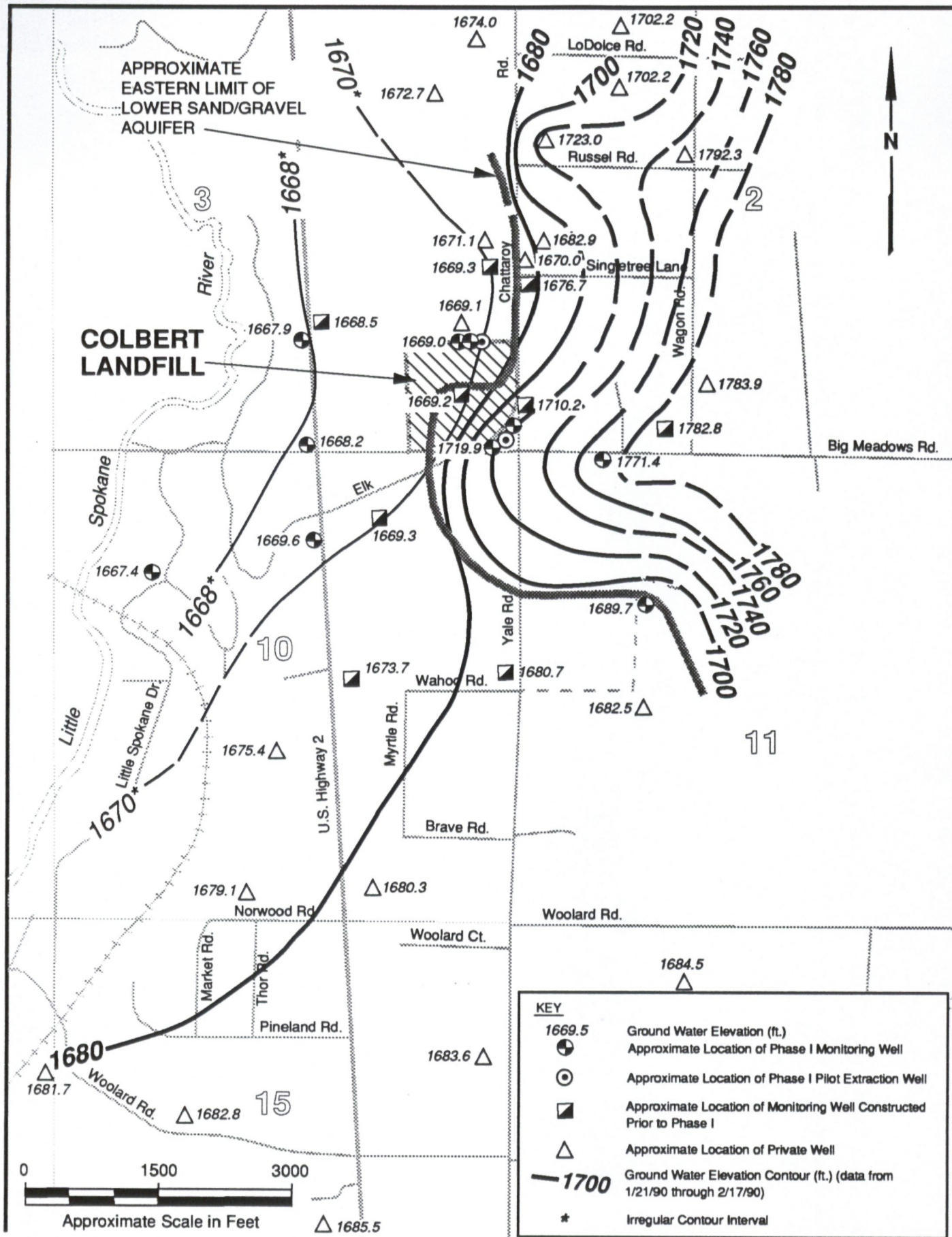
Generalized East-West Geologic Profile

Figure 1-4



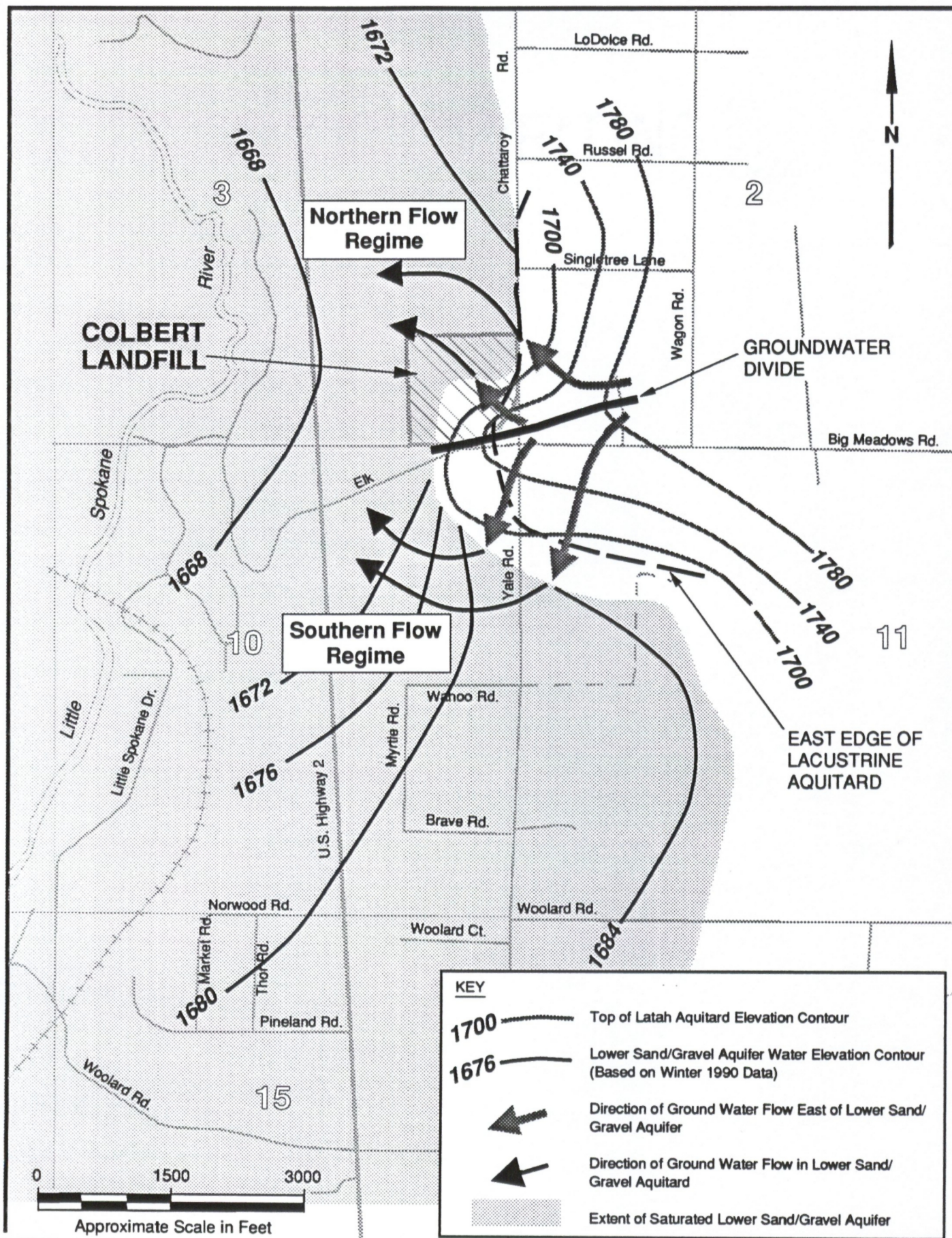
Upper Sand/Gravel Aquifer
Groundwater Elevation Contours

Figure 1-5



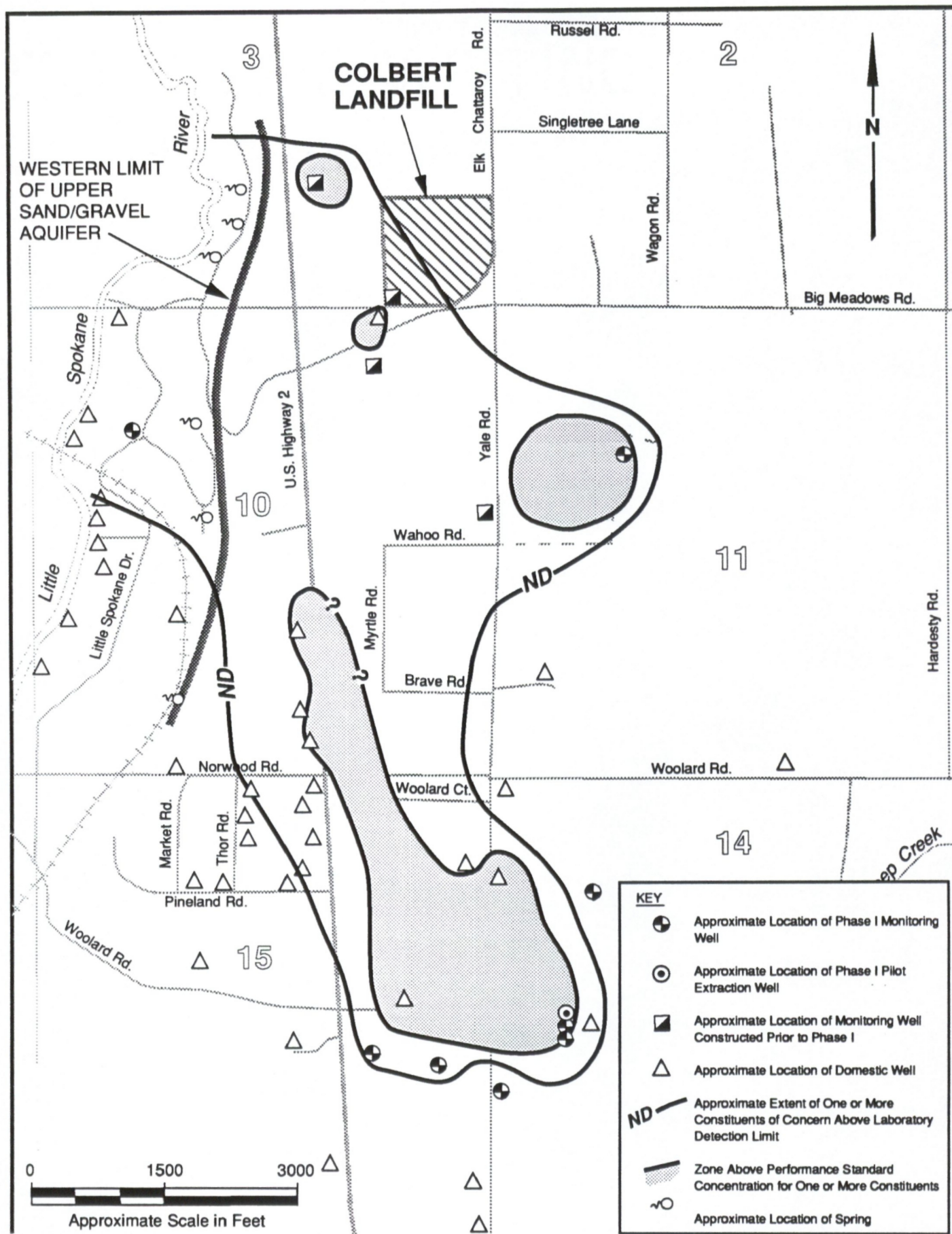
Lower Aquifers
Groundwater Elevation Contours

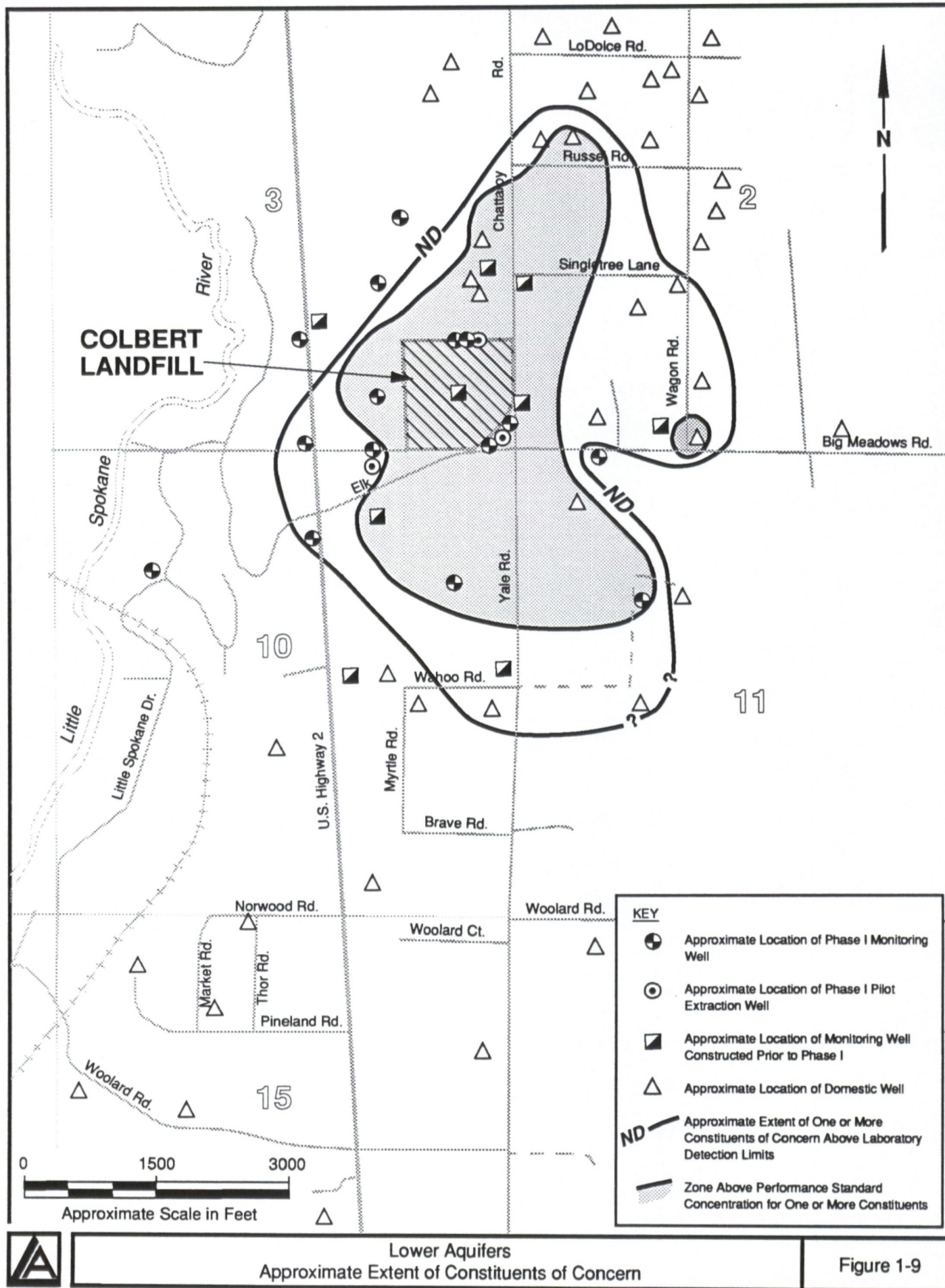
Figure 1-6

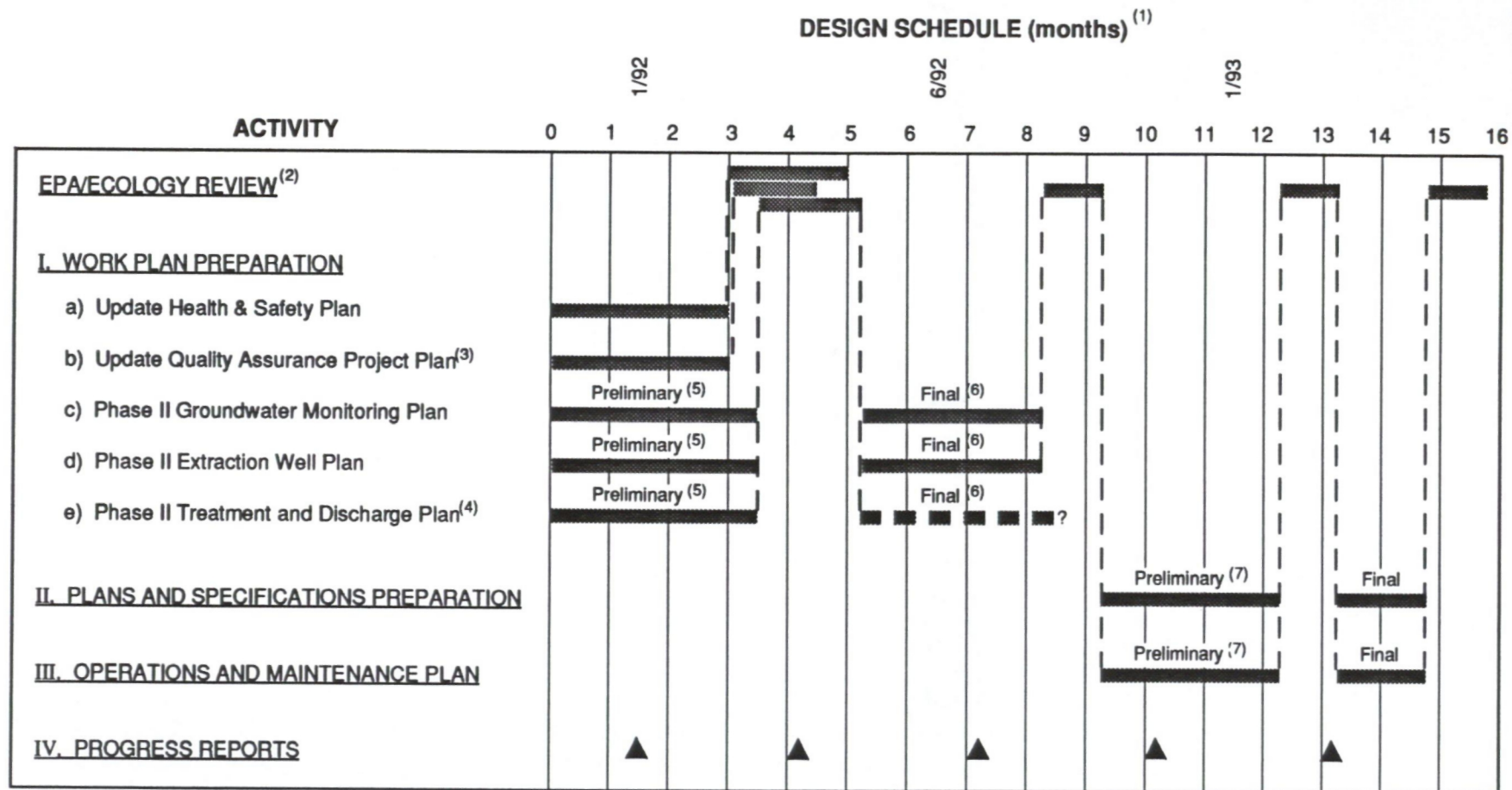


Conceptual Model
Lower Aquifers Groundwater Flow

Figure 1-7







Phase II Design
Estimated Schedule

Figure 1-10

TABLE 1-1
PROJECT PERFORMANCE CRITERIA^{(a)(b)}
COLBERT LANDFILL RD/RA

Constituent of Concern	Performance Standards	Evaluation Criteria
1,1,1-Trichloroethane (TCA)	200	200
1,1-Dichloroethylene (DCE)	7	7
1,1-Dichloroethane (DCA)	4050	4050
Trichloroethylene (TCE)	5	5
Tetrachloroethylene (PCE)	0.7	7
Methylene Chloride (MC)	2.5	25

(a) From Consent Decree Scope of Work (U.S. District Court 1988).

(b) All concentrations in parts per billion (ppb).

2.0 MONITORING SYSTEM DESIGN

This section describes the design of the Monitoring System. Monitoring System design includes selection of groundwater monitoring well locations and criteria for vertical monitoring intervals, which are addressed in this section. Other groundwater monitoring considerations, such as monitoring well construction and selection of groundwater sampling equipment, are addressed in subsequent sections of this Plan. Groundwater sampling procedures are addressed in the Quality Assurance Project Plan (Landau Associates 1992a). Sampling frequency and conformance monitoring criteria will be presented in the operations and maintenance plan (to be submitted with the plans and specifications).

2.1 BASIS FOR DESIGN

2.1.1 Consent Decree Requirements

Section V of the SOW specifies that groundwater monitoring of the Upper and Lower Sand/Gravel Aquifers be performed to assess the performance of the South and West Interception Systems, respectively. As stated in Section 1.1, the East Extraction System is intended for source control and, as such, is not subject to performance monitoring. Section V of the SOW is provided in Appendix A of this Plan.

Section V.A.(2)(a) of the SOW specifies that the South Monitoring System consist of at least three, and not more than eight, monitoring wells downgradient of the South Interception System. Additionally, two monitoring wells are to be placed at the outer limit of (crossgradient to) the South Interception System. The two cross gradient monitoring wells are to be constructed as extraction wells for possible incorporation into the South Interception System, if necessary.

The SOW specifies two sets of monitoring wells for downgradient monitoring of the West Interception System. The first set of monitoring wells (Set A) are for evaluation of West Interception System performance for those portions of the Lower Sand/Gravel Aquifer upgradient of existing supply wells. The second set of monitoring wells (Set B) are for evaluation of those portions of the Lower Sand/Gravel Aquifer not directly impacting the water quality of existing supply wells. Each set of West Monitoring System wells are to include three monitoring locations. Additionally, two monitoring wells are to be installed at the outer limits of (crossgradient to) the West Interception System. Similar to the South Monitoring System, the crossgradient wells are to be constructed as extraction wells for possible incorporation into the West Interception System.

The SOW requirement for location of Set A West Monitoring System wells upgradient of existing supply wells is intended to identify inadequate West Interception System performance well in advance of contaminated groundwater reaching the supply wells. As a result, the Set A monitoring wells will be constructed in close proximity to the leading edge of the plume (outside the zone of capture), as described in Section 2.2.

2.1.2 Technical Criteria

A groundwater monitoring system should typically meet certain technical criteria to provide effective performance monitoring for a groundwater interception system. Technical criteria include:

- Locating downgradient monitoring wells downgradient of the interception system capture zone
- Aligning downgradient monitoring wells with the areas of probable plume breakthrough (typically downgradient of the approximate midpoint between two extraction wells)
- Locating crossgradient monitoring wells outside of the lateral extent of the zone of capture for the interception system
- Providing adequate vertical monitoring within aquifers of significant saturated thickness (such as the Lower Sand/Gravel Aquifer).

Because of hydrogeologic conditions for the Site and the interaction of the West and East Interception Systems, it is not practicable (or desirable) to achieve all of these criteria at all Phase II groundwater monitoring locations. The two technical criteria not achieved at all locations are:

- Locating downgradient monitoring wells downgradient of the interception system capture zone
- Locating crossgradient monitoring wells outside of the lateral extent of the zone of capture for the interception system.

The first technical criterion is not achieved for Monitoring Well Location CD-31 (South System), and CD-44 and CD-45 (West System), because they are located within (or on the edge of) the capture zone for their respective interception systems. (See Section 2.2 for a description of monitoring well designations and planned locations.) However, all Constituents of Concern are below detection at these locations, and additional protection would not be achieved by selecting new locations downgradient from these existing monitoring locations. Thus, these locations meet the intent of the SOW.

The second technical criterion is not achieved by Monitoring Well Locations CD-34 and CP-S2 (South System), and, possibly, CD-45 (West System). The intent of the SOW is to locate crossgradient monitoring wells such that the wells can be converted to extraction wells and incorporated into the extraction system, if performance monitoring criteria are exceeded. However, the Upper Sand/Gravel Aquifer saturated thickness is too limited to allow construction of a crossgradient monitoring well that is both outside the zone of capture for the South Interception System and close enough to the outermost extraction well to be effectively used for extension of the interception system (i.e., the spacing between the wells becomes too great to maintain capture between the wells). It is proposed that the crossgradient monitoring wells be properly spaced for incorporation into the South Interception System (if needed), even though they are within the capture zone. If performance criteria are exceeded at these locations, additional monitoring wells will be constructed at the actual capture zone boundary to assess whether the criteria have actually been exceeded and interception system expansion is necessary.

The second technical criterion also may not be met by Monitoring Well CD-45, which is close to the capture zone boundary for the West Interception System (the identification of the capture zone boundary is not exact). However, CD-45 is an existing well location and Constituents of Concern have not been detected at this location. Selecting a new location farther away from the plume boundary would not be more protective of human health and is not necessary to meet the intent of the SOW.

2.2 MONITORING WELL LOCATION

A well designation system was developed for wells constructed during Phase I and will be extended to Phase II wells. Monitoring well designations include information on location, target aquifer, and (where appropriate) relative depth within the aquifer. Monitoring well locations are labelled according to the remedial system with which they are associated:

- East System monitoring wells: CD-20's
- South System monitoring wells: CD-30's
- West System monitoring wells: CD-40's

The target aquifer is indicated by the geologic unit letter designations described in Section 1.2.1. (e.g., A, B, C, D, E, or F). The relative depth of the well within the aquifer unit is indicated by number (1 to 3), with the number increasing with depth. For example, Wells CD-42C1 and CD-

42C3 are associated with the West System, and were installed near the top and base of the Lower Sand/Gravel Aquifer (Unit C), respectively.

Extraction wells are labeled according to the remedial system with which they are associated:

- East System extraction wells: CP-E's
- West System extraction wells: CP-W's
- South System extraction wells: CP-S's

As previously discussed, the South and West Monitoring Systems will include downgradient and crossgradient monitoring. Monitoring locations are dependent on the capture zone of the interception system and the location of extraction wells. Figures 2-1 and 2-2 show the capture zones and extraction well locations for the Upper and Lower Sand/Gravel Aquifers, respectively. A description of South and West Interception System design is provided in the Phase II Extraction Well Plan (Landau Associates 1992b).

Because of the high transmissivity of the Lower Sand/Gravel Aquifer, it is not practicable to separate the performance of the West and East Interception/Extraction Systems. Consequently, the capture zone for the Lower Sand/Gravel Aquifer results from operation of the West Interception System and the East Extraction System. Although groundwater monitoring for the West System does not directly address performance of the East Extraction System, operational changes to the East System would be considered if West System groundwater monitoring indicates such an adjustment is needed to improve contaminant capture within the Lower Sand/Gravel Aquifer. The capture zone for Upper Sand/Gravel Aquifer results from operation of the South Interception System.

The South and West Monitoring Systems will both include existing wells constructed during Phase I activities, and new wells. The South Monitoring System will include existing Monitoring Well CD-31A and three new wells (CD-36A through CD-38A) for downgradient monitoring. Crossgradient monitoring for the South Interception System will include existing Monitoring Well CD-34A on the southwest end of the South Interception System and a new extraction well (CP-S2) on the northeast end. If Phase II groundwater monitoring data indicate an additional extraction well is needed at the southwest end of the South Interception System, an additional extraction well will be constructed in the vicinity of Monitoring Well CD-34A (per the SOW crossgradient monitoring well construction requirements).

The locations of private domestic wells potentially impacted by constituent migration in the Lower Sand/Gravel Aquifer are shown on Figure 2-2. The West Monitoring System will include existing Monitoring Wells CD-41 (C1, C2, and C3) and CD-42 (C1, C2, and C3) and a new monitoring well location (CD-48) in the Set A downgradient monitoring wells, to provide groundwater monitoring upgradient of these domestic wells. Available hydrogeologic data indicate the Lower Sand/Gravel Aquifer is about 200 ft thick at proposed Monitoring Location CD-48. Based on the vertical monitoring guidance described in Section 2.3, it is anticipated that three monitoring wells will be constructed at Monitoring Location CD-48 to provide adequate vertical monitoring within the Lower Sand/Gravel Aquifer.

The Set B downgradient monitoring system will include existing Monitoring Wells CD-43 (C1, C2, and C3), CD-44C2 and CD-45C2. Available hydrogeologic data indicate the Lower Sand/Gravel Aquifer is about 125 ft thick at Monitoring Location CD-44 and about 185 ft thick at Monitoring Location CD-45. Based on the vertical monitoring guidance described in Section 2.3, one additional monitoring well would be constructed at Monitoring Location CD-44 and two additional monitoring wells at Monitoring Location CD-45. However, existing Monitoring Well CD-44C2 is screened near the center of the Lower Sand/Gravel Aquifer and the lower portion of the Aquifer is somewhat stratified, [see Appendix B of the Phase I Engineering Report (Landau Associates 1991) for Phase I boring logs]. As a result, additional monitoring wells will be constructed above and below the existing well to provide adequate vertical monitoring.

Crossgradient monitoring for the West Interception System will include existing Monitoring Location CD-45 at the north end and proposed Monitoring Location CD-48 at the south end. If Phase II groundwater monitoring data indicate an additional extraction well is needed at the north or south end of the West Interception System, an additional extraction well will be constructed in the vicinity of Monitoring Locations CD-45 or CD-48, respectively (per the SOW crossgradient monitoring well construction requirements).

The locations of proposed and existing South and West Monitoring System wells are shown on Figures 2-1 and 2-2, respectively. As shown on these figures, Phase II Monitoring Wells CD-31A, CD-34A, CD-44(C1, C2, and C3), CD-45 (C1, C2, and C3), and CP-S2 are within, or at the edge of, the capture zones for their respective interception systems. As stated in Section 2.1.2, it is preferable that monitoring wells be located outside the zone of capture. However, doing so at these locations would place the monitoring location well outside the zone where Constituents of Concern are present, reducing the effectiveness of the groundwater monitoring system as an early warning system for Interception System performance. Also,

placing the South Monitoring System crossgradient wells outside the projected zone of capture for the South Interception System would result in those wells being located too far away from the adjacent extraction wells to maintain capture between the two outside wells. As a result, it is recommended that initial Phase II groundwater monitoring be implemented at these locations. If applicable groundwater monitoring criteria (as presented in the SOW) are exceeded at these locations, the need for new monitoring locations outside the zone of capture will be evaluated by Spokane County, with the review and concurrence of EPA and Ecology.

It should be noted that Monitoring Locations CD-45 and CD-48 are proposed as both downgradient and crossgradient monitoring locations for the West Monitoring System. This multiple function results from fulfilling the performance monitoring requirements specified in the SOW, within the bounds of the hydrogeologic conditions exhibited by the Lower Sand/Gravel Aquifer.

The SOW specifies that 6 downgradient monitoring locations be utilized for the West Monitoring System. However, this requirement was based on hydrogeologic and contaminant distribution data from the RI that identified a potential downgradient plume width of about 4,300 ft. Subsequent characterization of site conditions performed during Phase I identified a more limited potential downgradient plume width of about 2,300 ft, as shown on Figure 2-3. Thus, the intent of the SOW West Monitoring System (one monitoring location about every 1,000 ft across the potential downgradient plume width) can be accomplished with three monitoring locations (CD-41, CD-42, and CD-43) instead of the six specified in the SOW.

The three West Monitoring System downgradient monitoring well locations, specified in the SOW but not required for downgradient monitoring, are proposed for construction to the north and south of (crossgradient to) the plume boundaries. Two well locations will be to the north of the plume (CD-44 and CD-45) and one well will be located to the south of the plume (CD-48), as shown on Figure 2-3. Groundwater monitoring at these locations will confirm that the plume is not expanding laterally and, potentially, spreading beyond the limits of the downgradient monitoring system; thus, fulfilling the intent of the SOW to protect downgradient water supplies.

The SOW specifies 8 monitoring locations for the West Monitoring System (6 downgradient and 2 crossgradient). However, the proposed West Monitoring System only includes 6 locations. The two SOW-specified monitoring locations not included in the proposed West Monitoring System will be retained for construction at a later date, if needed. The location

and timing for construction of these additional wells will be at the discretion of EPA and Ecology.

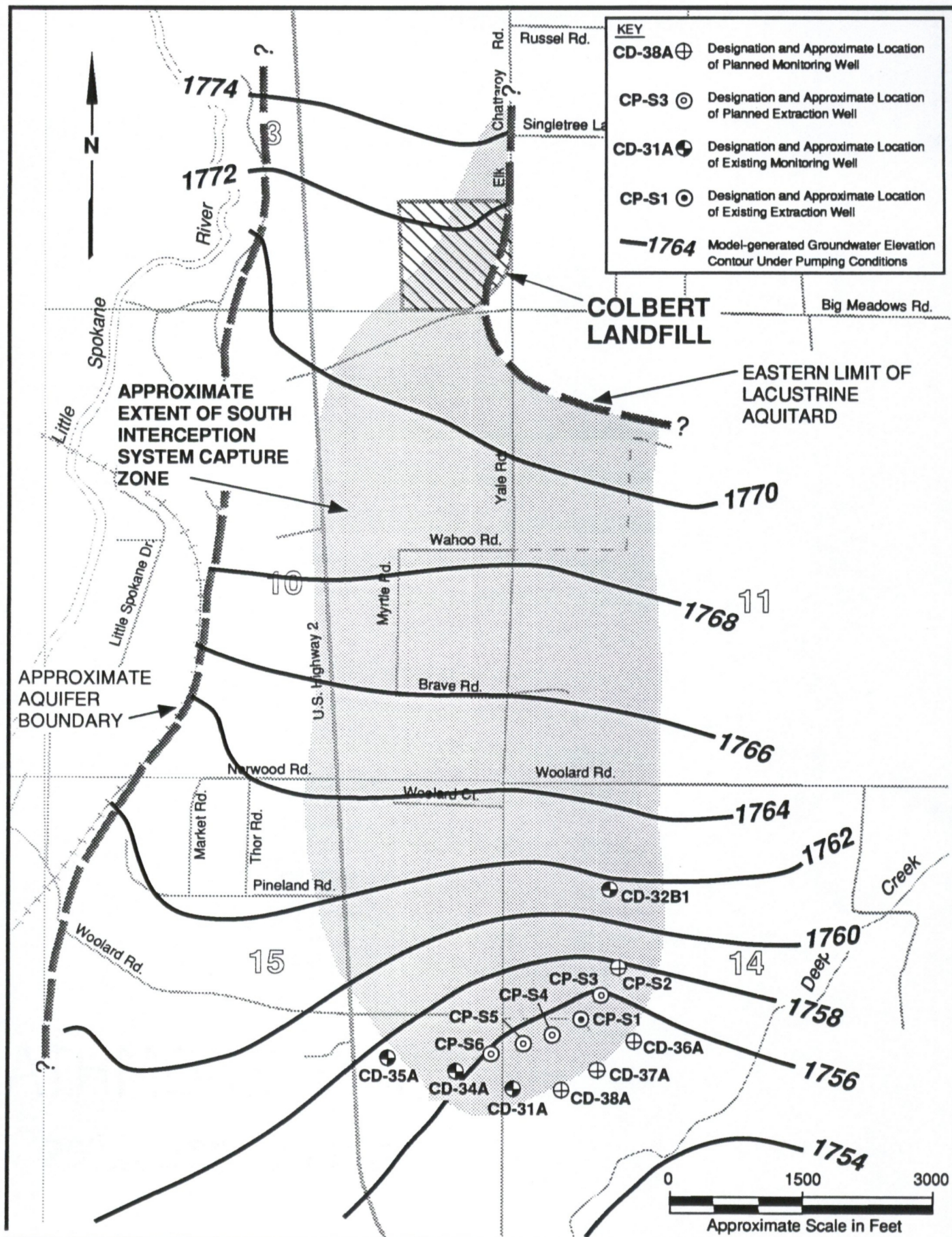
The screened intervals of existing South and West Monitoring System wells, and anticipated intervals for proposed monitoring wells, are presented in Table 2-1.

2.3 VERTICAL MONITORING

Guidance for determining vertical monitoring intervals within an aquifer were presented in the Phase I Groundwater Monitoring Well Construction Plan (Landau Associates 1989) and are generally applicable for Phase II groundwater monitoring. At locations where the aquifer of interest is less than about 50 ft thick, one monitoring well will be installed and will be screened within the lower two-thirds of the aquifer. If the target aquifer is greater than about 50 ft thick, but less than about 175 ft thick, two monitoring wells will be installed in a cluster (separate borings for each well); one well in the lower half of the aquifer and one well in the upper half of the aquifer. At locations where the target aquifer is greater than about 175 ft thick, three monitoring wells will be installed in a cluster; one monitoring well in each of the upper, middle, and lower thirds of the aquifer. Available data indicate the Lower Sand/Gravel Aquifer is the only aquifer where more than one monitoring interval will be required.

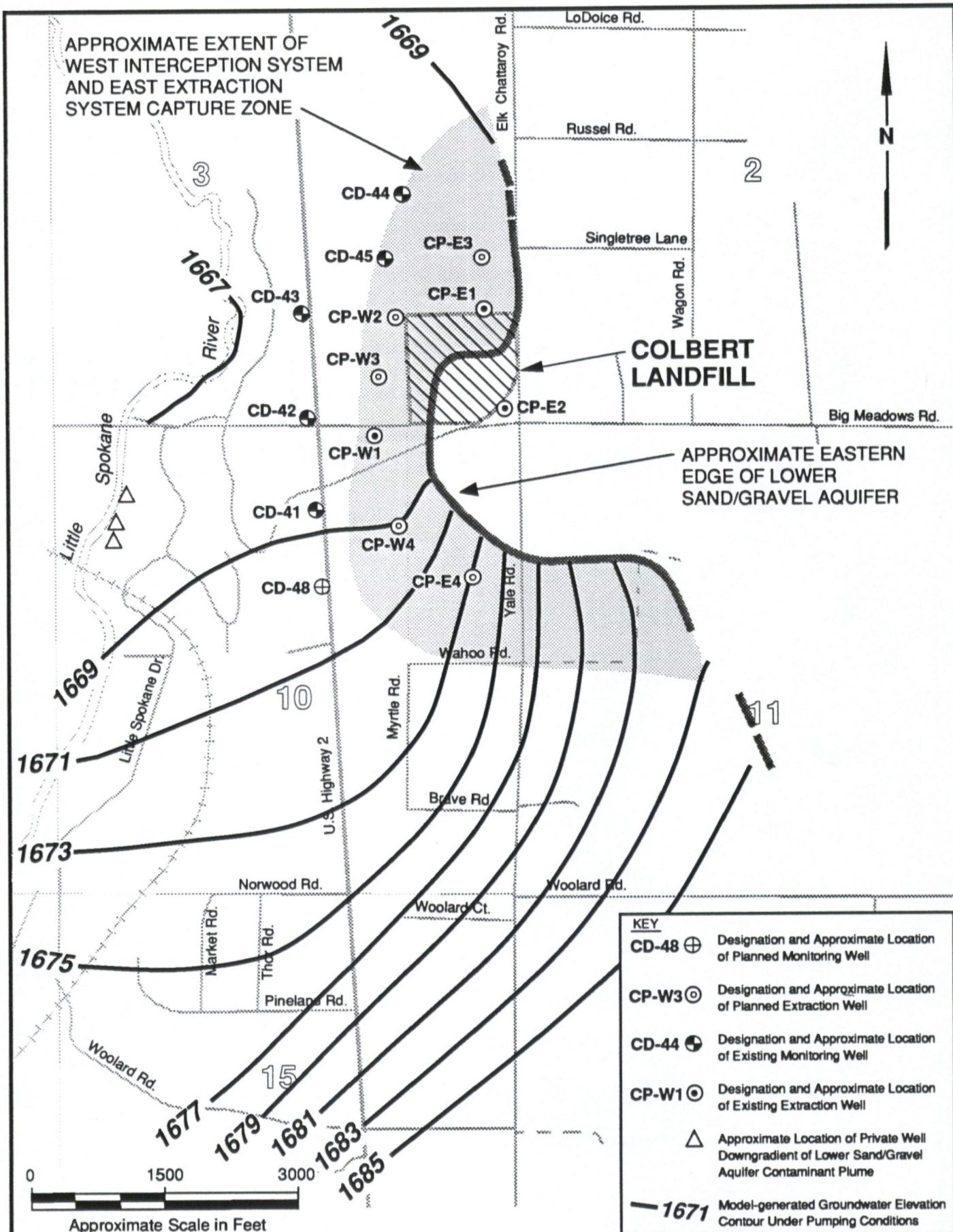
For Phase II groundwater monitoring locations that require more than one monitoring well, each well will be installed in a separate boring. This will create groups of wells (well clusters). Wells within a cluster will be located between about 15 and 30 ft apart to minimize the potential for interference (primarily grout intrusion) between wells in the cluster.

Screen lengths will not exceed 20 ft or 20 percent of the aquifer thickness, whichever is greater. Screened intervals will be selected based on hydrogeologic conditions observed in the field. Additionally, groundwater specific conductance will be monitored during drilling, and will be used as guidance for screened interval selection; Phase I data indicate that specific conductance exceeding about 500 μ S is typically associated with the presence of one or more of the Constituents of Concern [see Section 4.3.4 of the Phase I Engineering Report (Landau Associates 1991)].



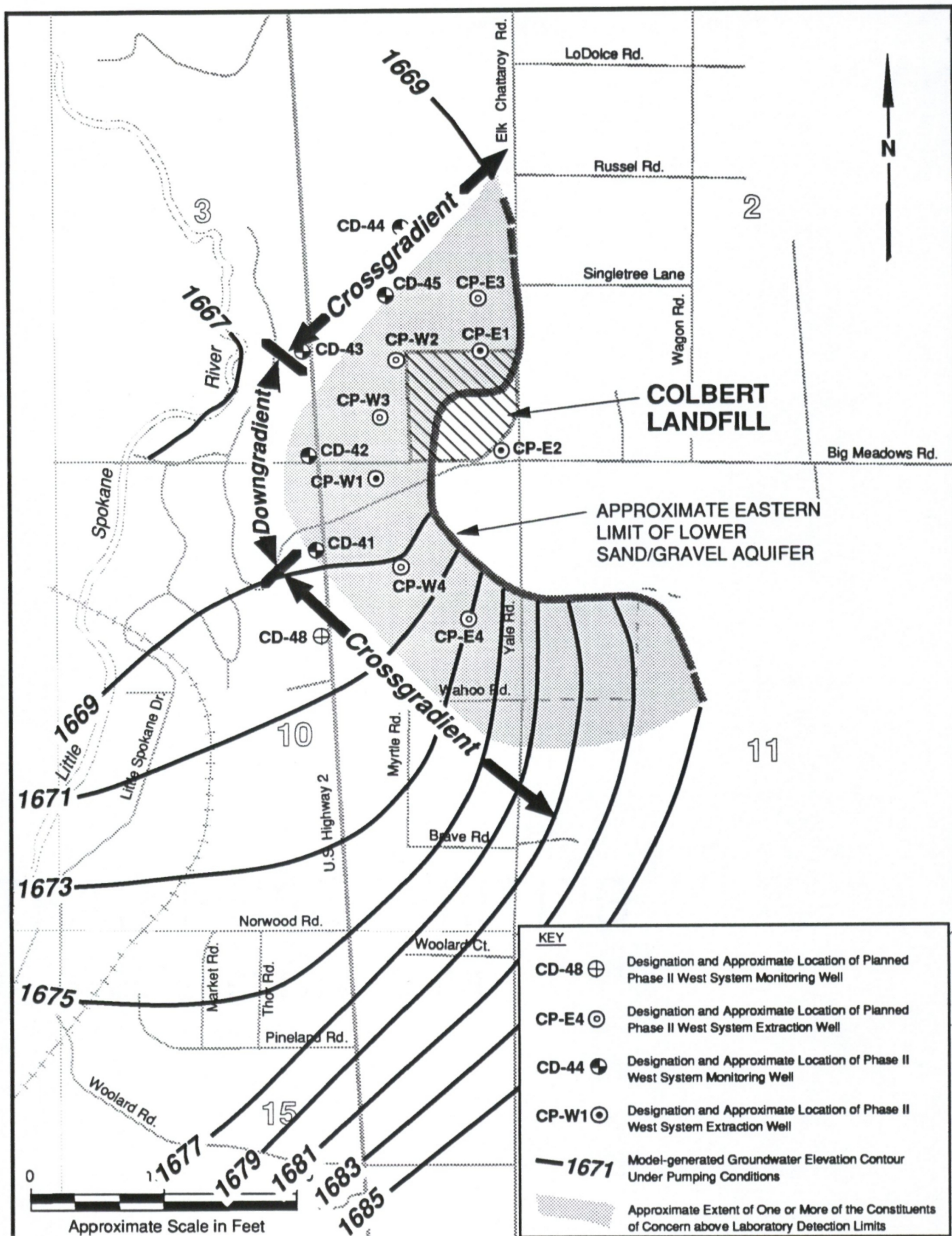
Upper Sand/Gravel Aquifer Capture Zone

Figure 2-1



Lower Sand/Gravel Aquifer Capture Zone

Figure 2-2



Lower Sand/Gravel Aquifer
Plume Downgradient and Crossgradient Areas

Figure 2-3

TABLE 2-1

SCREENED INTERVALS FOR THE SOUTH AND WEST
PHASE II GROUNDWATER MONITORING SYSTEMS
COLBERT LANDFILL RD/RA

Monitoring System/Function	Monitoring Well Designation ^(a)	Approximate Screened Interval ^(b)	Approximate Aquifer Saturated Interval ^(c)
<u>West Monitoring System</u>			
• Downgradient - Set A	CD-41C1	212-232	190(T)
	CD-41C2	270-290	
	CD-41C3	383-402	410(B)
	CD-42C1	207-225	190(T)
	CD-42C2	293-312	
	CD-42C3	381-400	400(B)
	CD-48C1 ^(d)	210-230 ^(e)	190(T)
	CD-48C2 ^(d)	280-300 ^(e)	
	CD-48C3 ^(d)	280-400 ^(e)	410(B)
• Downgradient - Set B	CD-43C1	209-228	170(T)
	CD-43C2	278-297	
	CD-43C3	381-400	400(B)
	CD-44C1 ^(d)	182-192 ^(e)	170(T)
	CD-44C2	225-245	
	CD-44C3 ^(d)	280-290 ^(e)	300(B)
	CD-45C1 ^(d)	180-190 ^(e)	170(T)
	CD-45C2	221-245	
	CD-45C3 ^(d)	325-345 ^(e)	360(B)
• Cross Gradient	CD-45C1 ^(d)	180-190 ^(e)	170(T)
	CD-45C2	221-245	
	CD-45C3 ^(d)	325-345 ^(e)	360(B)
	CD-48C1 ^(d)	210-230 ^(e)	190(T)
	CD-48C2 ^(d)	280-300 ^(e)	
	CD-48C3 ^(d)	380-400 ^(e)	410(B)
<u>South Monitoring System</u>			
• Downgradient	CD-31A	103-108	90(T)
	CD-36A ^(d)	100-110 ^(e)	
	CD-37A ^(d)	100-110 ^(e)	
	CD-38A ^(d)	100-110 ^(e)	
• Cross Gradient	CD-34A	100-110	
	CP-S2 ^{(d)(f)}	100-105 ^(e)	110(B)

(a) Existing well, except where indicated otherwise.

(b) Intervals in feet below ground surface.

(c) Depths in feet below ground surface. (T) = depth to top of aquifer; (B) = depth to bottom of aquifer.

(d) Proposed well.

(e) Approximate screened interval, actual screened interval will be selected based on hydrogeologic conditions encountered during boring advancement.

(f) Well to be constructed as an extraction well, utilizing the procedures described in the Phase II Extraction Well Plan (Landau Associates 1992b).

3.0 MONITORING WELL CONSTRUCTION

As previously discussed, the South and West Monitoring Systems will include existing wells (constructed during Phase I) and new wells (to be constructed during Phase II). This section presents the construction practices that will be used for Phase II groundwater monitoring well construction. A list of monitoring wells to be constructed during Phase II, and their anticipated screened zones, is presented in Table 3.1.

The SOW specifies that crossgradient monitoring wells be constructed for possible conversion to extraction wells (if necessary). As a result, crossgradient monitoring wells constructed during Phase II will be constructed using the procedures described in the Phase II Extraction Well Plan (Landau Associates 1992b), rather than those described in this document; Well CP-S2 is the only crossgradient monitoring well planned for construction during Phase II.

A total of 30 monitoring wells were constructed at 19 locations during Phase I activities. This extensive monitoring well construction program provided the opportunity to utilize different drilling methods, construction materials, and well installation techniques. Site-specific experience obtained during Phase I was incorporated into the development of Phase II monitoring well construction procedures, which are described in the following subsections.

3.1 DRILLING PROCEDURES

Both air rotary and cable tool drilling techniques were utilized during Phase I well construction. Observations made during Phase I indicate that cable tool drilling provides higher quality hydrogeologic data than does air rotary, and is also cost effective. As a result, cable tool drilling is the anticipated drilling method for monitoring wells constructed during Phase II. However, cable tool drilling is slow, and air rotary drilling may be used for the second or third monitoring well in well clusters, although the initial (deepest) well will be constructed using cable tool equipment.

Soil samples will be collected during drilling activities for geologic logging purposes. All soil samples will be logged using the soil classification system shown on Figure 3.1. Grab samples of soil cuttings will be collected at about 5-ft depth intervals for about the first 60 ft of boring advancement. Driven samples will be collected at about 5-ft intervals from about 60 ft below ground surface to the bottom of the boring. These sampling procedures will be followed for all South Monitoring System wells and the first (deepest) well in each West Monitoring

System well cluster. Grab samples on about 10 ft intervals will be collected for second and third monitoring wells in each cluster.

A lithologic log of the soil and rock encountered in each boring will be maintained using a form similar to that shown on Form 3.1. Additional information, such as the presence of water-bearing zones, the depth and type of soil samples collected, and any unusual or notable conditions encountered during drilling, will also be recorded on this form.

Drilling and sampling will extend into the Lacustrine Aquitard underlying the Upper Sand/Gravel Aquifer for South Monitoring System wells. The deepest monitoring well constructed in each West Monitoring System well cluster will be extended to the base of the Lower Sand/Gravel Aquifer, and subsequent wells in the cluster will extend to the target monitoring zone. Exceptions to this procedure will be made at well locations where borings were extended to the base of the Lower Sand/Gravel Aquifer during Phase I, but the monitoring well was screened at a higher elevation (Monitoring Locations CD-44 and CD-45 are examples).

If necessary, the casing shoe will be cut and casing separation will be verified prior to commencing monitoring well installation. After the casing shoe is cut, it will be isolated using bentonite chips or pellets.

Temporary steel casing will be selected such that the borehole is at least 3.75 inches larger than the diameter of the well pipe. Thus, at least a 6-inch diameter temporary casing will be used when installing 2.5-inch diameter monitoring wells. Although the State of Washington Well Construction Standards (WAC 173-160) specify a minimum 4.0-inch difference in diameter between the borehole and well pipe, Ecology provided a variance to the well construction standards for monitoring wells constructed during Phase I. The variance was granted because the well construction materials and installation procedures (as described in Section 3.2) allow construction of a competent annular seal within a smaller annulus. The variance request and variance are provided in Appendix B.

The temporary casing advanced during drilling of West Monitoring System wells will be downsized ("stepped down") in the Lacustrine Aquitard to create a seal and prevent potential downward migration of contamination from the Upper Sand/Gravel Aquifer. Consequently, each boring will be initiated with a temporary steel casing larger than that required to complete the well with the appropriate annular space. Borings for West Monitoring System wells will be initiated with an 8-inch diameter (or larger) temporary casing and stepped down to a 6-inch diameter casing. Drilling with 8-inch diameter temporary casing will continue until the Lacustrine Aquitard is encountered (this aquitard is anticipated to be greater than 50 ft in

thickness). After drilling into the aquitard about 5 ft, the casing will be driven about an additional 5 ft to create a seal. The casing size will then be stepped down to 6-inch diameter and drilling will continue through the Lacustrine Aquitard to the target depth in the Lower Sand/Gravel Aquifer.

3.2 MONITORING WELL INSTALLATION

Monitoring well installation will be accomplished in general accordance with the Washington State Minimum Standards for Construction and Maintenance of Wells (WAC 173-160). It is anticipated that cable tool equipment will be used for monitoring well installation. All permanent well casing, centralizers, and equipment used downhole (such as tremie pipe) will be cleaned using a hot water pressure wash prior to installation, as described later in Section 3.5.

All monitoring wells (excluding crossgradient monitoring wells constructed as extraction wells) will be constructed using 2.5-inch ID Schedule 80 PVC pipe. The permanent casing will be installed with stainless-steel centralizing devices located above and below the screen section to provide a filter pack of consistent dimension in the vicinity of the well screen. If conditions at individual wells warrant installation of a blank section below the screen, the filter pack will be extended 2-3 ft below the screened section.

It is important that permanent well casing be installed (and backfilled) without small radius bends so that groundwater sampling equipment can be lowered down the well. A bailer, or other appropriate equipment (such as a pump blank), will be lowered to the bottom of the well periodically during well installation to evaluate permanent casing alignment. Additionally, tension will be maintained on the well pipe to maintain alignment during backfilling of the annular space.

The target zones for all monitoring wells are anticipated to consist of fairly coarse materials (sand and gravel). However, zones of silty sand and gravel, and interbedded silt and sand, were encountered during Phase I in the Upper and Lower Sand/Gravel Aquifers. Consequently, two well screen/filter pack combinations will be used. A 0.020-inch slot screen and 10-20 silica sand filter pack will be used for relatively homogenous sand and gravel zones. A 0.010-inch slot screen and 20-40 silica sand filter pack will be used for stratified zones with fine-grained (silt or clay) units, and sand and gravel zones with greater than about 20 percent fines (material finer than the U.S. Standard No. 200 sieve).

Filter pack material will be installed in the annulus between the temporary steel casing and the permanent well screen casing. The sand will be poured slowly from the surface. Filter

pack material will be maintained approximately 3 ft above the bottom (inside) of the temporary casing to maintain formation stability. During installation of filter pack material, frequent measurements will be made to determine the depth to the top of the filter pack material, height of the filter pack above the bottom of the steel casing, and remaining distance to the planned position of the bentonite seal. The filter pack will be extended from at least 0.5 ft below the base of the well screen to approximately 3-5 ft above the top of the well screen.

High solids bentonite grout (Pure Gold Grout) will be used to create the annular seal for South and West Monitoring System wells constructed during Phase II. Pure Gold Grout achieves 30 to 35 percent solids, which is at least 50 percent greater than the 20 percent (or lower) solids achieved by standard bentonite grout. Pure Gold Grout will be placed at a unit weight of at least 10 pounds per gallon, and the grout weight will be measured periodically during placement using a mud balance.

Pure Gold Grout was used as the annular sealant for most groundwater monitoring wells constructed during Phase I, and performed very well. However, excessive grout loss (greater than 50 percent) occurred in some high permeability portions of the unsaturated zone, and bentonite chips were used to create a seal in these high permeability zones. Bentonite chips will be used during construction of Phase II monitoring wells, if similar conditions are encountered.

At least 2 ft of fine sand (20-40 silica sand, or equivalent) will be placed above the filter pack to minimize the possibility of grout intrusion into the filter pack. A sample of water will be obtained from the monitoring well following placement of the initial batch of grout to verify that grout has not intruded into the filter pack and entered the monitoring well. Similar procedures were followed during construction of Phase I monitoring wells, and filter pack grout intrusion was not observed in any of the Phase I monitoring wells.

The annular sealant will be installed using a tremie pipe lowered to near the top of the fine sand layer, so that water and sediment within the well casing are displaced upward when grout is pumped into the annulus. Care will be taken to pump the first portion of grout into the annulus at a low rate to avoid disturbing the bentonite plug. Also, the end of the tremie line will include a fitting to divert grout flow laterally, further reducing the potential for grout intrusion into the fine sand layer or underlying filter pack. The annular sealant will be placed to within about 5 ft of the surface and will be allowed to set up for at least 12 hours prior to installing the surface seal.

A concrete surface seal will be installed above the annular sealant. Bentonite chips may be used to stiffen the top of the grout material prior to installing the surface seal. A locking steel

monument cover will be installed to protect the monitoring well at the surface. A concrete pad or metal posts will be constructed around the steel casing in accordance with WAC 173-160-510.

Well construction as-built information will be recorded on a form similar to Form 3-2. Relevant information, including drilling method, the amounts and installation depths of well construction materials, and grout weights will be recorded to document final (100 percent) design of the well.

An elevation survey will be conducted following monitoring well installation to establish elevations (National Geodetic Vertical Datum) for the top of PVC casing, top of the monument cover steel casing, and the ground surface. The PVC casing and monument cover will be surveyed to the nearest 0.01 ft, and the ground surface will be surveyed to the nearest 0.1 ft. Figures 3-2 and 3-3 show typical monitoring well construction details for the Upper Sand/Gravel Aquifer and Lower Sand/Gravel Aquifer, respectively.

3.3 MONITORING WELL DEVELOPMENT

Monitoring wells are developed to remove suspended formation materials introduced into the borehole and filter pack during drilling and well installation activities, and to remove fine-grained material (if present) from the native soil adjacent to the filter pack. Proper well development results in lower turbidity water samples.

The effectiveness of different development methods varies depending on the type of aquifer material, depth to water, height of the water column, and other factors. Air lift techniques, mechanical surging, pumping, and a combination of these methods were utilized for development of Phase I monitoring wells, and were effective. These well development methods will also be used for monitoring wells constructed during Phase II.

Air lift can be used for both surging and pumping wells, and is most appropriate for coarse aquifers such as the Upper and Lower Sand/Gravel Aquifers. However, air lift efficiency decreases as the pumping submergence decreases (pumping submergence is the length of air line below the pumping water level divided by the total length of air line in the casing, and is expressed as a percentage). A pumping submergence of about 20 to 30 percent is typically needed for effective air lift development.

Air lift development can entrain air in the filter pack or aquifer formation if the air line is extended into the screened section. Consequently, air lift development will only be used for monitoring wells where adequate submergence can be attained without extending the air line into the screened section, although the air line may be initially operated at the base of the well

to suspend any settled sediment. Based on these criteria, air lift development may not be appropriate for development for the South Monitoring System wells, and possibly some of the West Monitoring System wells that are installed near the top of the Lower Sand/Gravel Aquifer.

For wells where air lift is not effective, development will be accomplished by pumping the well using an air-driven pump, possibly in combination with surging. Surging will be accomplished mechanically using a surge block, or by rapidly raising and lowering the pump.

Well development will be considered complete when at least 10 casing volumes have been purged and the discharge water appears to be low in turbidity. If the turbidity does not decline sufficiently during initial development, the well will be allowed to "rest" for at least 24 hours and development procedures will be reinitiated. If turbidity cannot be reduced to an acceptable level, the well will either be reconstructed, or chemical analysis will be restricted to parameters not significantly impacted by suspended sediments. Well development data will be documented on a form similar to that provided on Form 3-2.

3.4 DISPOSAL PROCEDURES FOR SOIL CUTTINGS AND EXCESS GROUNDWATER

Disposal procedures for soil and excess groundwater generated during monitoring well drilling, development, and sampling activities are described in the Project Health and Safety Plan (Landau Associates 1992c), and are summarized in this section. Soil and groundwater will be considered nonhazardous for borings and monitoring wells located outside the landfill refuse disposal area, provided residual volatile organic compounds are not detected at levels above background in vapors emitted from these materials.

Vapors emitted from soil cuttings and excess groundwater will be screened in the field for volatile organic compounds using a photoionization meter. If concentrations of volatile organic compounds are present above background levels in excess groundwater, air will be bubbled through the water to remove residual volatile organics prior to disposal at the work station. Soil cuttings will be disposed of in the refuse area, if concentrations of volatile organic compounds are detected above background or if desired for aesthetic reasons. Alternatively, soil and excess groundwater may be disposed of within the refuse disposal area in lieu of screening for organic vapors.

3.5 EQUIPMENT DECONTAMINATION PROCEDURES

All material and equipment that enter (or comes in close contact with) the borehole will be thoroughly cleaned prior to use for each monitoring well, as required by WAC 173-160-530.

Drill rigs, temporary and permanent casing, drill rods and bits, and bailers will be washed with a hot water pressure wash; nondedicated (soil and water) sampling equipment and sounding devices (water level indicators and measuring tapes) will be cleaned using a detergent wash and distilled water rinse. The Project Health and Safety Plan (Landau Associates 1992c) should be referred to for a more detailed description of decontamination procedures.

3.6 CONSTRUCTION QUALITY ASSURANCE

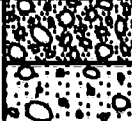
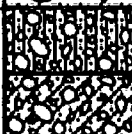
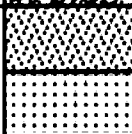
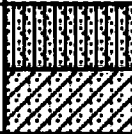







Construction quality assurance is an integral component of any construction project. It provides the basis for assessing whether the construction conforms to the design specifications and, if not, whether the as-built structure is adequate to achieve its design objective.

A number of construction quality assurance procedures will be implemented for construction of Phase II monitoring wells. Many (but not all) of these procedures are described in preceding sections of this Plan. This section provides a summary of construction quality assurance procedures:

- Boring advancement
 - Geologic conditions encountered during boring advancement will be logged by a geologist or engineer.
 - Exploration logs will be compared to collected soil samples for accuracy and consistency by a geologist or engineer other than the geologist or engineer that initially logged the exploration. If practicable, a single individual will provide this accuracy check for all well locations to provide consistent description of geologic materials.
 - Daily drilling and well installation progress will be recorded on a form similar to that shown on Form 3-3.
 - The boring will be sounded, periodically, throughout the day to determine boring depth.
 - The length of temporary steel casing will be measured and recorded each time a new casing section is added to determine the depth of steel casing.
- Monitoring well installation
 - All materials will be inspected for flaws and defects prior to installation. Materials will also be inspected to verify that they conform to the material specifications.
 - The quantities and depth of installation for all materials will be measured and documented (as shown on Form 3-2).
 - Well casing alignment will be periodically checked during placement of annular materials to verify that adequate clearance for sampling pump installation exists.

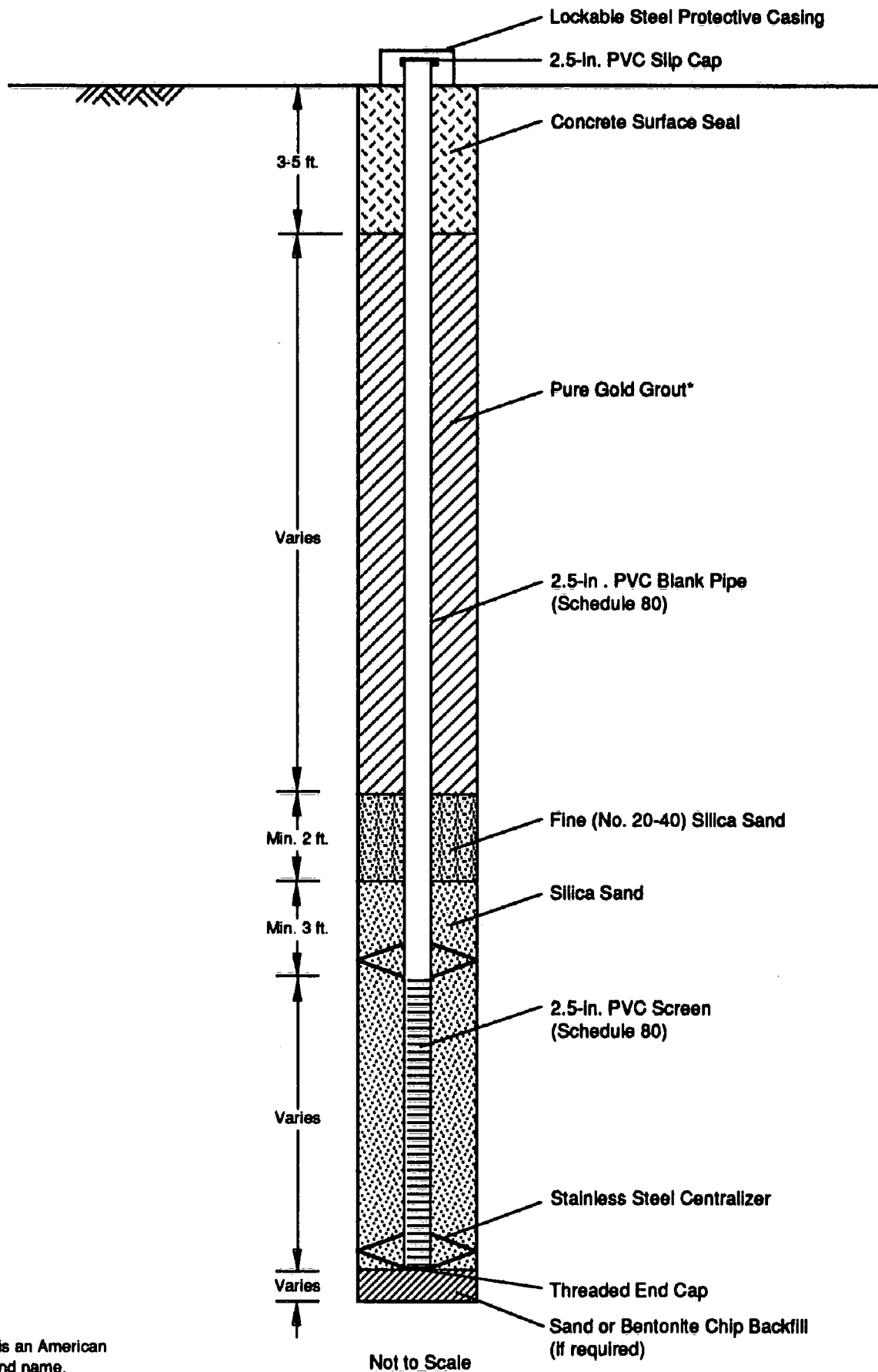
- The unit weight of the annular sealant will be measured, periodically, using a mud balance to verify that the specified material density is being achieved.
- The water column within the monitoring well screened zone will be checked during grout placement to verify grout has not intruded into the well casing.
- Monitoring well development
 - Monitoring well development practices will be documented on a form similar to that shown on Form 3-2.
 - A groundwater sample collected from the well subsequent to development will be analyzed for turbidity to assess the effectiveness of development.

Soil Classification System

MAJOR DIVISIONS		GRAPHIC SYMBOL	USCS LETTER SYMBOL (1)	TYPICAL DESCRIPTIONS (2)(3)
COARSE-GRAINED SOIL (More than 50% of material is larger than No.200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No.4 sieve)	CLEAN GRAVEL (Little or no fines)		GW Well-graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GP Poorly graded gravel; gravel/sand mixture(s); little or no fines
				GM Silty gravel; gravel/sand/silt mixture(s)
				GC Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No.4 sieve)	CLEAN SAND (Little or no fines)		SW Well-graded sand; gravelly sand; little or no fines
				SP Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM Silty sand; sand/silt mixture(s)
				SC Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No.200 sieve size)	SILT AND CLAY (Liquid Limit less than 50)		ML Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity	
			CL Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay	
			OL Organic silt; organic, silty clay of low plasticity	
	SILT AND CLAY (Liquid Limit greater than 50)		MH Inorganic silt; micaceous or diatomaceous fine sand or silty soil	
			CH Inorganic clay of high plasticity; fat clay	
			OH Organic clay of medium to high plasticity; organic silt	
HIGHLY ORGANIC SOIL			PT Peat; humus; swamp soil with high organic content	

- Notes:
- USCS letter symbols correspond to the Unified Soil Classification System. Dual letter symbols (e.g., SM-SP) for a sand or gravel indicate a soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications. Only the first letter symbol's respective pattern is shown on logs.
 - Soil descriptions shown on logs are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D 2488.
 - Soil description terminology (which is based on visual estimates of the percentages of each soil type) is as follows:
 Primary Soil Type(s) - e.g., "GRAVEL," "SAND," "SILT," "CLAY," etc.
 Secondary Soil Type(s) (>15%) - e.g., "gravelly," "sandy," "clayey," etc.
 Modifier(s) (>5% and ≤15%) - e.g., "with gravel," "with sand," "with clay," etc.
 Minor Component(s) (≤5%) - e.g., either "trace gravel," "trace sand," "trace clay," etc., or no mention of minor soil type



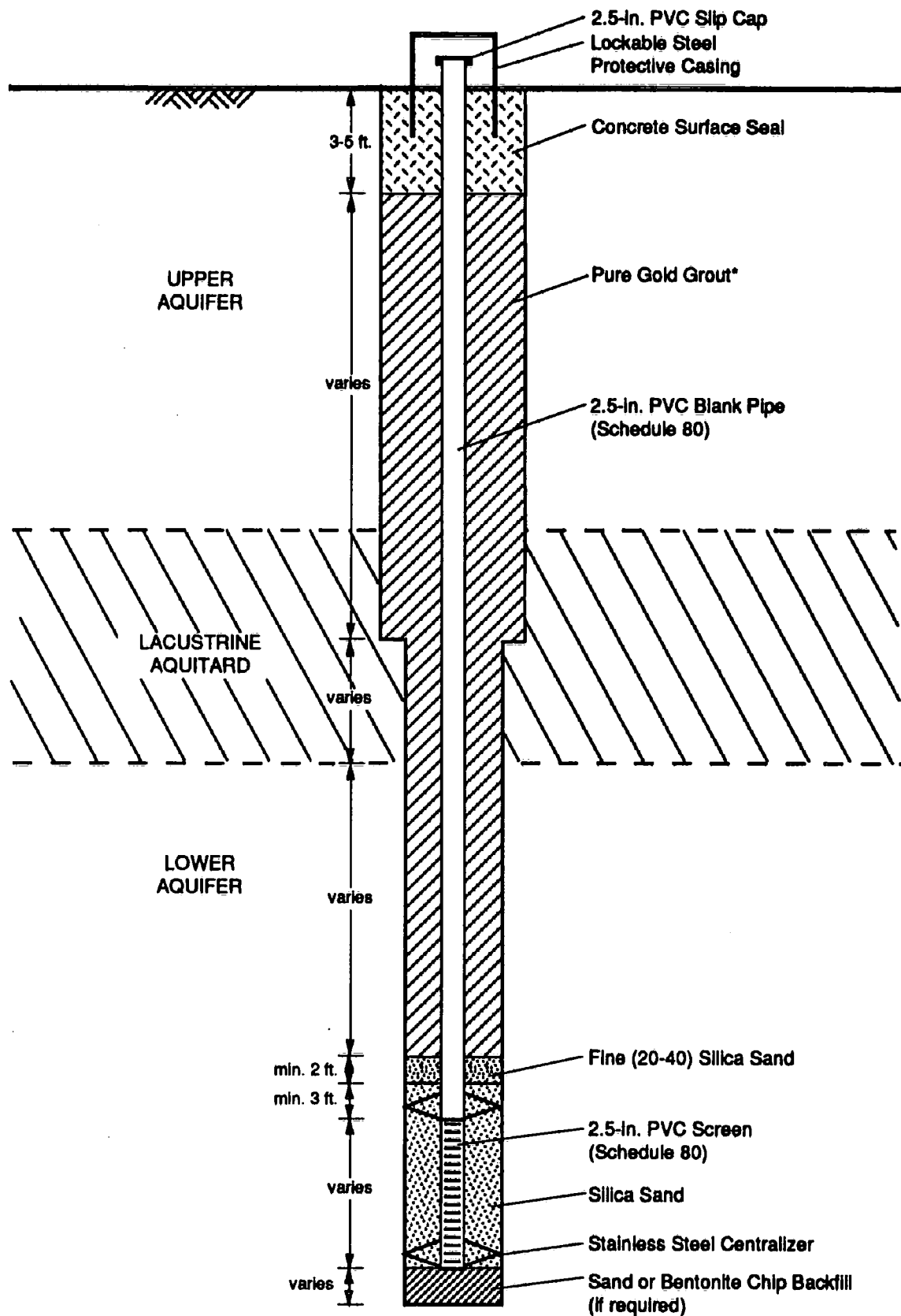


* Pure Gold is an American Colloid brand name.



Typical Monitoring Well Design
Upper Sand/Gravel Aquifer

Figure 3-2



* Pure Gold is an American Colloid brand name.



Typical Monitoring Well Design
Lower Aquifers

Figure 3-3

Log of Exploration

Exploration No. _____
Sheet _____ of _____

<p>Client/Owner _____ Project No. _____</p> <p>Start Date _____ Hour _____</p> <p>Ground Surface Conditions _____</p> <p>Weather Conditions _____</p> <p>Landau Rep. _____ Contractor/Operator _____</p> <p>Exploration Method _____</p> <p>Hammer Weight & Stroke _____</p>	<p>Location Sketch (show dimensions to mapped features) </p> <p>Surface Elevation _____ Datum _____</p>
--	---

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-----	--	--	--	--	--	--	--

☐ No Recovery
☒ Disturbed Sample
☐ Undisturbed Sample

3/90
Sampler: SPT, 2.4-in. ID Drive (2.4 D), Thinwall (TW), Shelby
Tube (S), Bulk (B), etc. (Add "C" to sampler type if a catcher is used)

Finish Date _____ Hour _____ Continued ☐

As-built Well Completion Form

Project: _____
Project No.: _____
Well(s) No.: _____
Drilling Co.: _____
Installation Start Date: _____ Hour: _____
Installation Finish Date: _____ Hour: _____
Well Type: ☐ Single ☐ Nested ☐ Clustered

EQUIPMENT USED

- ☐ Hollow Stem Auger
☐ Cable Tool
☐ Air Rotary
☐ Other _____

MATERIALS USED

_____ Sacks of _____ Sand
_____ Sacks of _____ Concrete/Cement
_____ Sacks of _____ Grout Mix Used
_____ Sacks of Powdered Bentonite
_____ Pounds of Bentonite Pellets/Chips
_____ Feet of _____ Inch PVC Blank Casing
_____ Feet of _____ Inch PVC Slotted Screen

GROUT WEIGHT

Date: _____ Time: _____ Grout Wt.* _____
Date: _____ Time: _____ Grout Wt.* _____
Date: _____ Time: _____ Grout Wt.* _____
Date: _____ Time: _____ Grout Wt.* _____
Date: _____ Time: _____ Grout Wt.* _____
* lbs./gal.

DEVELOPMENT

Method of Development: _____

Begin Date: _____ Time: _____

Finish Date: _____ Time: _____

Yield: _____ Time From: _____ To: _____ Date: _____

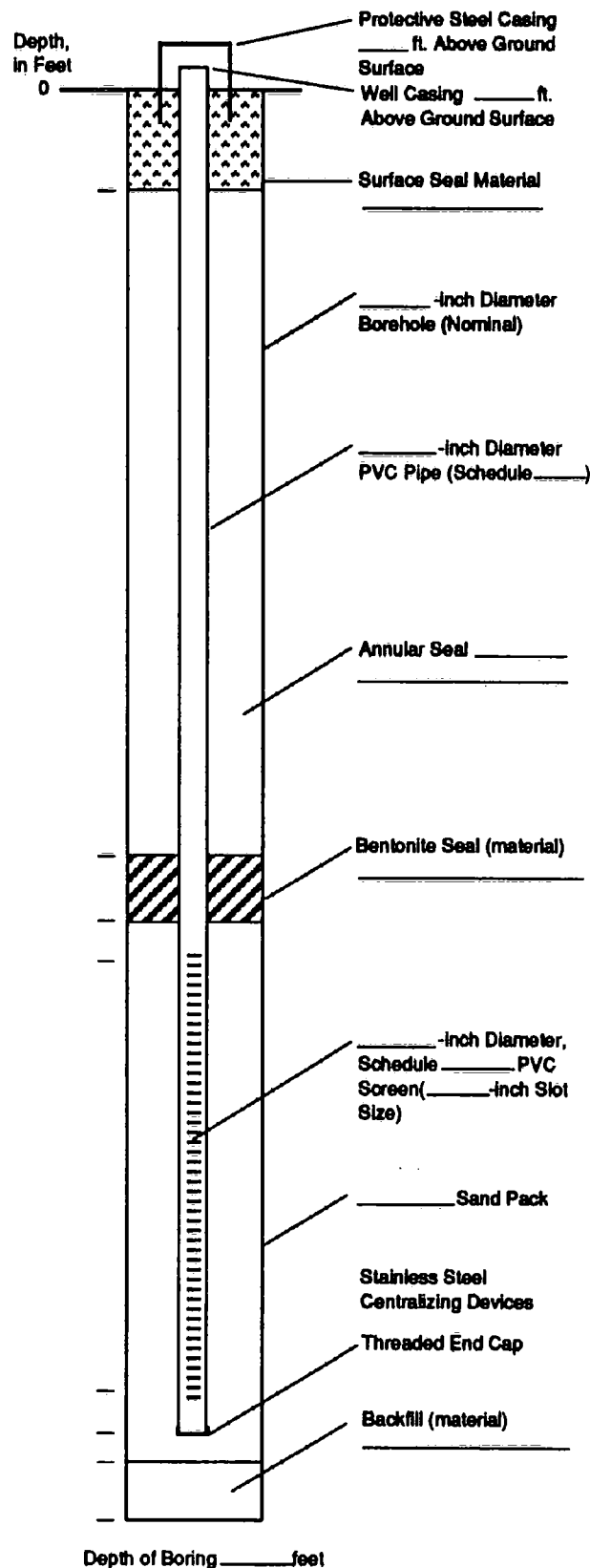
Estimate of Total Water Removed During Development: _____ Gallons

Description of Turbidity at End of Development: ☐ Clear ☐ Slightly Cloudy
☐ Mod. Turbid ☐ Very Cloudy

Odor of Water: _____

Water Discharged To: _____

Depth to Water After Development: _____ Feet



2/92

TABLE 3-1

WELL DESIGNATION AND ANTICIPATED SCREENED INTERVAL
FOR MONITORING WELLS TO BE CONSTRUCTED DURING PHASE II
COLBERT LANDFILL RD/RA

Monitoring Well Designation	Anticipated Screened Interval ^(a)
CD-48C1	210-230 ^(b)
CD-48C2	280-300 ^(b)
CD-48C3	380-400 ^(b)
CD-44C1	182-192 ^(b)
CD-44C3	280-290 ^(b)
CD-45C1	180-190 ^(b)
CD-45C3	325-345 ^(b)
CD-36A	100-110 ^(b)
CD-37A	100-110 ^(b)
CD-38A	100-110 ^(b)
CP-S2 ^(c)	100-105 ^(b)

(a) Intervals in feet below ground surface.

(b) Approximate screened interval, actual screened interval will be selected based on hydrogeologic conditions encountered during boring advancement.

(c) Well to be constructed as an extraction well, utilizing the procedures described in the Extraction Well Plan (Landau Associates 1992b).

4.0 GROUNDWATER SAMPLING

Postconstruction groundwater sampling will be a long-term operational activity designed to evaluate performance of the South and West Interception Systems. Primary considerations for groundwater sampling are sampling equipment, sampling procedures and analytical parameters, and sampling frequency.

This section describes the sampling equipment that will be used for the South and West groundwater monitoring systems. Sampling procedures and analytical parameters are described in the Phase II Quality Assurance Project Plan (QAPjP; Landau Associates 1992a). The SOW specifies the sampling frequency, and these sampling frequency requirements will be reiterated in the Project Operations and Maintenance Plan (to be submitted with Project plans and specifications.)

Dedicated groundwater sampling pumps will be installed in all wells in the South and West Monitoring Systems. Air-driven bladder or piston pumps will be used for all monitoring wells, except that electric submersible pumps may be used for crossgradient monitoring wells constructed for possible conversion to extraction wells.

Bladder, piston, and submersible pumps are all capable of providing high quality groundwater samples for chemical analyses. Cost is the primary basis for pump selection, including consideration of capital costs and operational costs. Bladder pumps are inexpensive, but have a high operational cost because their slow discharge rate (about 0.2 gpm) results in a long purge time for wells with a large purge volume. Piston pumps have a higher capital cost than bladder pumps but are capable of pumping at a much higher discharge rate (about 1.5 gpm for the Bennet piston pump). A submersible pump has a capital cost similar to a piston pump and is capable of pumping at a much higher discharge rate (100 gpm or greater). However, submersible pumps require an electrical source, which can be expensive for well locations remote from available power.

Bladder pumps will be installed in monitoring wells with small purge volumes (well water columns of less than about 40 ft). Piston pumps will be installed in monitoring wells with large purge volumes, except that submersible pumps will be considered for crossgradient monitoring wells constructed to extraction well standards.

It is anticipated that bladder pumps will be installed in all South System groundwater monitoring wells, and some of the West System groundwater monitoring wells screened within

the upper portions of the Lower Sand/Gravel Aquifer. The anticipated pump type for Phase II groundwater monitoring wells is provided in Table 4.1.

TABLE 4-1

ANTICIPATED PUMP TYPE FOR THE SOUTH AND WEST
GROUNDWATER MONITORING SYSTEMS
COLBERT LANDFILL RD/RA

Monitoring System	Monitoring Well Designation ^(a)	Screened Interval ^(b)	Approximate Well Water Column Height ^(c)	Pump Type
<u>West Monitoring System</u>				
	CD-41C1	212-232	57	Piston
	CD-41C2	270-290	115	Piston
	CD-41C3	383-402	227	Piston
	CD-42C1	207-225	50	Piston
	CD-42C2	293-312	137	Piston
	CD-42C3	381-400	225	Piston
	CD-43C1	209-228	53	Piston
	CD-43C2	278-297	122	Piston
	CD-43C3	381-400	225	Piston
	CD-44C1 ^(d)	182-192	17	Bladder
	CD-44C2	225-245	70	Piston
	CD-44C3 ^(d)	280-290	115	Piston
	CD-45C1 ^(d)	180-190	15	Bladder
	CD-45C2	221-245	70	Piston
	CD-45C3 ^(d)	325-345	170	Piston
	CD-48C1 ^(d)	210-230	55	Piston
	CD-48C2 ^(d)	280-300	125	Piston
	CD-48C3 ^(d)	380-400	225	Piston

4-3

LANDAU ASSOCIATES, INC.

TABLE 4-1

ANTICIPATED PUMP TYPE FOR THE SOUTH AND WEST
GROUNDWATER MONITORING SYSTEMS
COLBERT LANDFILL RD/RA

Monitoring System	Monitoring Well Designation ^(a)	Screened Interval ^(b)	Approximate Well Water Column Height ^(c)	Pump Type
<u>South Monitoring System</u>				
	CD-31A	103-108	18	Bladder
	CD-34A	100-110	20	Bladder
	CD-36A ^(d)	100-110	20	Bladder
	CD-37A ^(d)	100-110	20	Bladder
	CD-38A ^(d)	100-110	20	Bladder
	CD-39A ^(d)	100-110	20	Bladder
	CP-S2 ^(d)	100-110	20	Piston/Submersible

(a) Existing well, except where indicated otherwise.

(b) Intervals in feet below ground surface.

(c) Based on an approximate depth to water of 90 ft and 175 ft for South and West System wells, respectively.

(d) Well proposed for Phase II construction.

5.0 HEALTH AND SAFETY

Detailed Phase II health and safety procedures are presented in the Project Health and Safety Plan (Landau Associates 1992c). As discussed in the Health and Safety Plan, Level D⁽¹⁾ and modified Level D personal protection is anticipated to be appropriate during most monitoring well construction activities. Monitoring of chemical exposure (via inhalation) in the vicinity of drilling operations will be conducted using a photoionization meter. If appropriate, well construction activities will be temporarily suspended and the level of protection upgraded to Level C.

A safe work policy for technical field personnel and subcontractors will apply at all times. Observance of standard industrial safety is an important consideration in the vicinity of drilling rigs, and a factor limiting personnel access in the vicinity of operations. Drilling contractors will be responsible for operating drill rigs and associated equipment in a safe and appropriate manner during all Phase II well construction activities. To limit access, the area surrounding monitoring well installation activities will be clearly marked with caution tape or traffic cones. This tape (or cones) will be clearly visible along perimeters of the work zone to present a visual barrier to entry.

Heat stress is another important consideration when working during hot weather, particularly when wearing protective clothing. Water will be available at each work site. If weather and working conditions warrant, a reduced work/rest cycle will be adopted.

(1) Refer to the Project Health and Safety Plan (Landau Associates 1992c) for a description of the clothing and equipment required for the different levels of personal protection.

6.0 REFERENCES

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Section V of the Project Consent Decree Scope of Work

(Reformatted from the Original)

COLBERT LANDFILL RD/RA
CONSENT DECREE SCOPE OF WORK

SECTION V.

Phase II Design and Operation

A. Extraction, Water Treatment, and Discharge - South System

1. Bases for Design --

a. The goal of the south ground water interception system is to prevent the spread of contaminated ground water downgradient⁽¹⁾ of the interception system. Both the Government Plaintiffs and the County recognizes that the interception system, during operation, may not capture 100 percent of the plume which contains constituents of concern, but consider it reasonable to design an interception system which approaches this goal.

b. Location of the Interception System -- The ground water interception system will be located based on information developed during Phase I pilot studies. Important considerations in placement of the interception system will include: concentrations and areal distributions of contaminants in the ground water; and hydrogeologic conditions identified during Phase I, such as saturated thickness of the aquifer, hydraulic conductivity, hydraulic gradients, and aquifer boundary conditions.

c. Treatment System -- The treatment system will be designed to meet the Performance Standards at the point of discharge from the treatment system. This design will be based on the maximum anticipated contaminant mass influent rate and treatment efficiency levels demonstrated during Phase I pilot testing. Compliance with applicable air emission standards will be addressed during treatment system design in accordance with the provisions of Section V.D.

d. Cost Effectiveness -- Design of the Phase II interception/treatment/discharge system will also consider cost effectiveness. The minimum level of effort required for the south interception system is prevention of the spread of the constituents of concern at concentrations which exceed the evaluation criteria identified in Table IV-1. The treatment and discharge

(1) For the purpose of this Scope of Work, the terms upgradient and downgradient refer to the ground water gradient under non-pumping, steady state conditions, unless specifically indicated otherwise.

system must meet the evaluation criteria. The County, at its discretion, may either select proven technology or new technologies which attain these criteria more economically. The system plans will be submitted to the Government Plaintiffs for review and approval.

2. Design Components and Bases for Decision--

a. Monitoring -- The County may, at its discretion, decide, following completion of Phase I, to install up to three additional monitoring wells to better characterize the hydrogeology and contaminant distribution in the shallow aquifer. If so decided, the County will provide plans to the Government Plaintiffs for review, identifying the number and location of additional monitoring wells. Information from these wells would be used to confirm or refine data from Phase I prior to construction of the Phase II system.

As the plan for the Phase II ground water interception system is finalized, a ground water monitoring program will be instituted to evaluate interception system performance. The interception system monitoring wells will consist of at least three, and not to exceed eight, monitoring wells located downgradient of the ground water interception system, and two monitoring wells placed at the outer limit of the interception system. The wells at the outer limits will also serve as extraction wells, if adjustment control criteria (as described in Section V.A.2b) are exceeded in these wells during monitoring. The County will determine if the interception system monitoring wells will include wells installed as part of the Phase I program. Phase I wells not included as interception system monitoring wells will be monitored at the County's discretion. A more extensive monitoring system may be proposed by the County if they determine that additional monitoring is appropriate. Plans for additional monitoring would be provided to the Government Plaintiffs for review and approval.

Chemical analysis for the interception system monitoring wells will be accomplished for the four indicator compounds identified in Table V-1, using EPA Method 8010 (SW-846, USEPA, 1986), on the frequency described in the following paragraph. Methylene chloride and tetrachloroethylene have been excluded from Table V-1 due to the high probability of laboratory contamination for methylene chloride, and the limited distribution in the ground water of both methylene chloride and tetrachloroethylene. Although methylene chloride and tetrachloroethylene do not form the basis for interception system design and operation criteria, they will be included in chemical analysis annually for at least the first five years of system operation. If methylene chloride and/or tetrachloroethylene are detected at concentrations above the Table IV-1 evaluation criteria during Phase I or during annual sampling described in this

paragraph, the compounds will be monitored at the frequency of the other compounds listed in Table V-1. After this five-year period, the need for continued analysis for methylene chloride and tetrachloroethylene will be re-evaluated.

Quarterly sampling and analysis will be conducted for each of the interception system monitoring wells, except that the performance monitoring wells will initially be sampled more frequently as subsequently described in Section V.A.2b. Quarterly sampling of each well will be continued until no exceedance of the operational control criteria (as described in Section V.A.2b) is identified for twelve consecutive quarters. In the event that, for a particular well, no exceedances occur during the twelve quarters, sampling frequency will be reduced to an annual basis for the next two years. If no exceedances have been identified during this five-year period, the County will, with Government Plaintiff's approval, determine whether continued monitoring is appropriate based on the need to assure long-term protection of purveyor wells at the site. If, in a particular monitoring well (or converted extraction well, as described below in Section V.A.2b.), no exceedances occur, but an increasing trend in concentrations is identified that is likely to result in exceedance of the operational control criteria, the County will implement a longer-term sampling and analysis program that assures the protection of human health.

In the event that a single exceedance of an applicable criteria (Table IV-1 or Table V-1) occurs, a follow-up sample will be obtained. An exceedance will be confirmed if concentrations exceeding an applicable criteria are identified in three consecutive samples collected at two-week intervals. If an exceedance is confirmed, the County will submit, for the Government Plaintiffs' review and approval, a program including additional monitoring wells or additional monitoring of existing wells to address the exceedance.

The criteria presented in this section (V.A.2a) applies only to monitoring during system operation. While the interception system is shut off and on standby status, this system operation criteria is superseded by the monitoring criteria described in Section X of this Scope of Work.

b. Interception System -- In order to meet the goals identified in Section V.A.1a, the County will accomplish the following:

- Conduct the Phase I pilot studies to obtain the needed aquifer characteristics for designing an interception system.

TABLE V-1
OPERATIONAL AND ADJUSTMENT CONTROL
CRITERIA^(a)

Compound	Maximum Operational Control Criteria ^(b) (ppb)	Maximum Adjustment Control Criteria ^(c)
1,1,1-Trichloroethane	60	130
1,1-Dichloroethylene	NA ^(d)	5
1,1-Dichloroethane	1,200	2,600
Trichloroethylene	NA ⁽⁴⁾	4

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- (a) Maximum criteria are presented in this table. Criteria may be lower than these values, as described in Sections V.A.2b. and V.C.2b. of this Scope of Work.
- (b) Operational control criteria as represented by 30 percent of the Table IV-1 evaluation criteria.
- (c) Adjustment control criteria as represented by 65 percent of the Table IV-1 evaluation criteria.
- (d) Resulting concentration is too low to be accurately quantified using standard laboratory procedures. This constituent will not be included as part of the operational control criteria.

- Complete a preliminary design engineering report detailing the most probable aquifer characteristics, design parameters and project costs. The system will be designed utilizing capture zone analysis to achieve overlapping cones of depression, and such that the total pumping capability of the interception well system is sufficient to intercept the plume to the extent described within this section (V.A.2b). Selection of pumping test methodologies and capture zone analysis will be subject to the review and approval of the government plaintiffs.

The extraction wells will be installed near the leading edge of the plume. Extraction wells will be installed in succession from the center to the outermost limits of the plume. The spacing of the wells will be determined by the County based on hydrogeologic and chemical data. Additional wells will be installed until the ground water at the outermost limits is below the adjustment control criteria. The outermost wells will be included as interception system monitoring wells, and will be constructed such that conversion to extraction wells is possible if exceedances of adjustment control criteria are subsequently identified. If an outboard monitoring well is converted to an extraction well, an additional monitoring well (constructed for possible conversion to an extraction well) will be installed to the outside of the converted monitoring/extraction well.

The design criteria will serve as a guide to the use of the aquifer capture analysis referred to earlier in this section. The basis for the south interception system design will be that the average concentrations of the contaminants of concern in the upper aquifer downgradient of the interception system are predicted to be no greater than 15 percent of the Table I-1 Performance Standards based on capture zone analysis.

Commencing at a mutually agreed upon time following startup of the interception system, the downgradient interception system monitoring wells will be sampled monthly (for Table V-1 constituents) for two years, or some other mutually agreed-upon length of time. The Government Plaintiffs will select at least three, and not to exceed eight, of these downgradient wells for use as performance monitoring wells. These wells will be selected to provide a representative sampling of constituent concentrations across the full width of the interception system. Based on statistical analysis of the chemical data from these performance monitoring

wells, a baseline concentration⁽²⁾ will be identified for each Table V-1 constituent. This baseline concentration will be equal to the average of the time-averaged concentrations in the three (or more) performance monitoring wells after the data associated with the expected gradual changes following startup are eliminated.

Operational control criteria for the south interception system will be developed for the appropriate indicator compounds (1,1,1-TCA and 1,1-DCA) from Table V-1 and will be equal to the lesser of: 1) the baseline concentration plus 15 percent of the Table IV-1 evaluation criteria or 2) 30 percent of the Table IV-1 Adjustment control criteria for the south interception system will be developed for the indicator compounds from Table V-1 and will be equal to the lesser of: 1) the baseline concentration plus 50 percent of the Table IV-1 evaluation criteria or 2) 65 percent of the Table IV-1 evaluation criteria.

If after confirmation (as defined in Section V.A.2a), the average concentration in the three designated downgradient monitoring wells exceeds the adjustment control criteria for two consecutive quarters (or some other mutually agreed-upon timeframe that will better allow reflection of system adjustments in downgradient monitoring wells) following system adjustment (as described previously for operational control criteria exceedances), the interception system will be modified. Additionally, the interception system will be modified if any individual downgradient performance monitoring well exceeds the Table IV-1 evaluation criteria for two consecutive quarters (or other time period, as described above). Modifications may include increasing pumping rates (for one or more wells), adding extraction wells to the system, or other methods of correcting interception system deficiencies. The County will submit a proposal for interception system modifications to the Government Plaintiffs for review and approval.

In addition to the operation and adjustment control criteria described above, should any downgradient performance monitoring well, following the development of baseline concen-

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- (2) If the resulting concentration is below the Practical Quantitation Limit (PQL) for a Table I-1 constituent, the PQL reported for EPA Method 8010 (USEPA, "Test Methods for Evaluating Solid Waste," SW-846, 3rd Ed. 1986) will be used as the baseline concentration for that constituent. evaluation criteria. If, after confirmation (as defined in Section V.A.2a) the average concentration in the three performance monitoring wells exceeds the operational control criteria, the County will re-evaluate the operation of the interception system. Should this re-evaluation indicate adjustments to the system are appropriate, the County will submit a proposal for interception system adjustment to the Government Plaintiffs for review and approval. Adjustments may include increasing pumping rates (for one or more wells), or other adjustments to the existing system considered appropriate for improving interception system efficiency.

trations, exhibit anomalous concentrations or trends in concentrations that are inconsistent with effective interception system performance (such as an increasing trend in concentration projected to lead to a long-term exceedance of the Table V-1 adjustment control criteria), the County will evaluate the operation of the interception system. This evaluation will address the potential cause(s) of the anomaly and possible system adjustments or modifications (if appropriate), and will be presented to the Government Plaintiffs in a written report for their review within 60 days of evaluation.

Prior to establishing baseline concentrations, the operational and adjustment control criteria for the interception system will be the Table IV-1 evaluation criteria. These criteria will be applied on an individual basis to each downgradient interception system monitoring well.

If it is determined by the County that an exceedance of the above criteria is the result of supply well interference with the interception system, adjustment to, or modification to, the system will include elimination of the interference. Elimination of the interference may require either partial or complete cessation of supply well use. The County will attempt to negotiate a settlement with the well owner. If an equitable agreement cannot be reached between the County and the well owner, the Government Plaintiffs may use their statutory authority to seek termination of usage for the interfering well.

Based on cost effectiveness or a determination by the County that acceleration of the cleanup is appropriate, the County may, at its discretion, propose additional upgradient extraction wells. Any such proposal will be submitted to the Government Plaintiffs for review and approval.

If ground water withdrawn by an extraction well meets the operational control criteria for two consecutive quarterly samplings, water from this well will not require treatment prior to discharge. If a subsequently confirmed exceedance of the operational control criteria is identified, treatment of water from the extraction well will be resumed.

Operation of an extraction well may be discontinued if ground water from that well meets the adjustment control criteria. If shutdown of the well thereby occurs, the well will be sampled as described above in Section V.A.2a for monitoring wells. If a subsequently confirmed exceedance of the adjustment control criteria or an identified trend of increasing chemical concentrations occurs that is projected to lead to an exceedance of the adjustment control criteria, the extraction well will be reactivated.

If contaminant concentrations in ground water entering an extraction well decrease (confirmed as described in Section V.A.2a for exceedances) to levels below the Table IV-1

evaluation criteria, pulse pumping may be initiated at the discretion of the County. Procedures for pulse pumping, which are protective of human health and the environment, will be provided to the Government Plaintiffs for review and approval.

c. Treatment System -- A water treatment system utilizing air stripping, designed to treat water to comply with the Performance Standards, will be installed. The treatment system design will use data developed during the Phase I pilot program. A facilities plan will be developed by the County and provided to the Government Plaintiffs for review and approval. The County may, at its discretion, select treatment system performance goals which provide a higher discharge water quality than that identified by the Performance Standards. Compliance with applicable air emissions standards is addressed in Section V.D.

In the event that water discharged from the treatment system exceeds the Table IV-1 evaluation criteria, necessary improvements or operational adjustments will be accomplished by the County after review and approval by the Government Plaintiffs. In the event that the treatment system cannot meet the Table IV-1 evaluation criteria for methylene chloride, the Government Plaintiffs may apply less stringent evaluation criteria for this constituent. Indicated exceedances will be confirmed using the same methodology described for monitoring wells in Section V.A.2a.

d. Discharge -- Disposal of treated water will be in a manner that meets the Table IV-1 evaluation criteria. Options include discharge to the Little Spokane River, discharge to Deep Creek, or recharge to the shallow aquifer (either upgradient or downgradient of the interception system). Discharge to Deep Creek and recharge to the shallow aquifer will require the specific approval of the Government Plaintiffs. Plans for the discharge system will be submitted to the Government Plaintiffs for review and approval.

B. Extraction, Water Treatment, and Discharge - East System

1. Bases for Design --

a. Performance Standards for Ground Water -- The east ground water extraction system is intended for source control near the landfill site and not as an interception system.

b. Location of the East Source Control System -- The source control extraction system will be located based on information developed during Phase I pilot studies. Important considerations in placement of the extraction system will include concentrations and areal distributions of contaminants in the ground water; and hydrogeologic conditions such as saturated thickness

of the aquifer(s), hydraulic conductivity, horizontal and vertical hydraulic gradients, and aquifer boundary conditions.

c. Treatment System -- The treatment system will be designed to meet the Performance Standards at the point of discharge from the treatment system. This design will be based on the maximum anticipated contaminant mass influent rate and treatment efficiency levels demonstrated during Phase I pilot testing. Compliance with applicable air emission standards is addressed in Section V.D.

d. Cost Effectiveness -- Design of the Phase II - East extraction/treatment/discharge system will also consider cost effectiveness. The extraction/treatment/discharge system must meet the Table IV-1 evaluation criteria with respect to treatment and discharge. The County may, at its discretion, either select proven technology or new technologies which more economically attain these criteria. The system plans will be submitted to the Government Plaintiffs for review and approval.

2. Design Components and Bases for Decision--

a. Monitoring -- The east extraction system is intended for source control and not plume interception. Consequently, no performance monitoring is required beyond that which is considered necessary by the County to evaluate treatment efficiency and to demonstrate the cost effectiveness of continued operation of the east system as a Remedial Action component for the lower aquifer(s). Phase I - East monitoring wells will be monitored at the discretion of the County.

In the event that monitoring wells upgradient of the extraction system, and outside its capture zone, show a consistent rise in contaminant concentrations that is likely to result in exceedance of the Table IV-1 evaluation criteria, additional upgradient (as previously defined) monitoring will be accomplished. The County will select the number and location of additional monitoring wells, subject to review and approval by the Government Plaintiffs. The County will determine if existing wells will be used or new monitoring wells will be installed.

The criteria presented in this section (V.B.2a) applies only to monitoring during system operation. This criteria is superseded, once the system is shut off, by the monitoring criteria described in Section X of this Scope of Work.

b. Source Control System -- The County will propose a source control system that includes six or more extraction wells. These wells will be installed to the north and to the east of the landfill site at locations exhibiting elevated contaminant concentrations and adequate hydrogeologic properties for sustained extraction at or near the flow rates set forth in the ROD.

As presently envisioned by the County, the system will include at least three extraction wells to the north and three to the east of the landfill. The locations and flow rates of these wells will be determined by the County from Phase I study data and additional monitoring well data. The design for this system will be provided to the Government Plaintiffs for review and approval.

Based on the following criteria, the County may, at its discretion, expand the source control system beyond six extraction wells: aquifer yield; potential contaminant spreading induced by the addition of extraction wells; impact of increased contaminant mass loading to the treatment facility on meeting the Table IV-1 evaluation criteria; and system redundancy with respect to the west interception system and the objectives of the lower aquifer(s) Remedial Action.

Operation of an extraction well may be discontinued, upon approval of the Government Plaintiffs, if the well is not yielding, on a continuous basis, at least 50 percent (20 gpm) of the average discharge rate described in the ROD. If pumping is terminated for an extraction well, that well may, at the County's discretion, be included in the lower aquifer(s) monitoring program.

If deemed appropriate by the County, extraction wells may be subjected to pulse pumping rather than continuous pumping. Plans for pulse pumping will be submitted to the Government Plaintiffs for review and approval.

If ground water withdrawn by an extraction well meets the Table V-1 operational control criteria for two consecutive quarterly samplings, water from this well will not require treatment prior to discharge. If a subsequently confirmed exceedance of the operational control criteria is identified, treatment of water from the extraction well will be resumed.

Pumping may be discontinued from extraction wells if it is determined by the County, with review and approval by the Government Plaintiffs, that continued operation of the well(s) is no longer cost effective. Cost effectiveness will be evaluated based on the extent to which the extraction well(s) are achieving the system goal of source control, and whether it is cost effective to extract contamination near the source rather than at the west interception system.

c. Treatment System -- A water treatment system utilizing air stripping, designed to treat water to comply with the Performance Standards, will be installed. The treatment system design will use data developed during the Phase I pilot program. A facilities plan will be developed by the Count and provided to the Government Plaintiffs for review and approval. The County, at its discretion, may select treatment system performance goals which provide a higher discharge

water quality than that identified by the Performance Standards. Compliance with applicable air emissions standards is addressed in Section V.D.

In the event that water discharged from the treatment system exceeds the Table IV-1 evaluation criteria, necessary improvements or operational adjustments will be accomplished by the County after review and approval by the Government Plaintiffs. Indicated exceedances will be confirmed by follow-up sampling and analysis using the same methodology described for monitoring wells in Section V.A.2.a.

In the event that the treatment system cannot meet the Table IV-1 evaluation criteria for methylene chloride, the Government Plaintiffs may apply less stringent evaluation criteria for this constituent. Indicated exceedances will be confirmed using the same methodology described for monitoring wells in Section V.A.2a.

d. Discharge -- Disposal of treated water will be in a manner that meets the Table IV-1 evaluation criteria. The County will choose the specific means of disposal; options include discharge to the Little Spokane River and recharge at or near the landfill site. The viability of treated water recharge at or near the landfill site will be evaluated by the County and may include consideration of cleanup acceleration resulting from contaminant flushing within the unsaturated zone, and the potential impact of increased contaminant loading on treatment system performance. If this evaluation confirms the viability of recharge, the County will submit a plan to the Government Plaintiffs for their review and approval.

C. Extraction, Water Treatment, and Discharge - West System

1. Bases for Design --

a. The goal of the west ground water interception system is to prevent the spread of contaminated ground water downgradient of the interception system. Both the Government Plaintiffs and County recognize that a higher level of protection is appropriate for that portion of the lower aquifer (downgradient of the interception system) within the zone of capture of existing supply wells, than for that portion of the aquifer downgradient of the interception system where contaminants can migrate directly to the Little Spokane River without impacting existing supply wells.

b. Location of the Interception System -- The ground water interception system will be located east of Highway 2 in proximity to the north-south alignment shown in the ROD.

c. Treatment System -- The treatment system will be designed to meet the Performance Standards at the point of discharge from the treatment system. This design will be based on the

maximum anticipated contaminant mass influent rate and treatment efficiency levels demonstrated during Phase I pilot testing. Compliance with applicable air emission standards will be addressed during treatment system design in accordance with the provisions of Section V.D.

d. Cost Effectiveness -- Design of the Phase II interception/treatment/discharge system will also consider cost effectiveness. The minimum level of effort required for the west interception system is prevention of the spread of the constituents of concern at concentrations which exceed the evaluation criteria identified in Table IV-1. The treatment and discharge system must meet these evaluation criteria. The County, at its discretion, may either select proven technology or new technologies which more economically attain these criteria. The system plans will be submitted to the Government Plaintiffs for review and approval.

2. Design Components and Bases for Decision--

a. Monitoring -- A monitoring program will be instituted to evaluate the Phase II interception system performance. Two sets of monitoring wells will be included in the west interception system performance monitoring program. The first set (set A) of monitoring wells will be utilized for evaluation of interception system performance for those portions of the lower aquifer within the capture zone of existing supply wells located downgradient of the interception system, and will consist of three monitoring wells located directly upgradient of the existing supply wells. The second set (set B) of monitoring wells will be utilized for evaluation of interception system performance for those portions of the lower aquifer not directly impacting the water quality of the existing supply wells, and will include three monitoring wells located downgradient of the interception system. Two additional monitoring wells placed at the outboard limit of the interception system will also be included in the interception system monitoring program. These outboard wells may also serve as extraction wells, if adjustment control criteria (as described in Section V.C.2b) are exceeded during monitoring.

The monitoring system may, at the discretion of the County, include new wells or, if appropriate, wells installed as part of the Phase I program. Phase I wells not included in the interception system performance monitoring program will be monitored at the County's discretion. A more extensive monitoring system may be proposed by the County if they determine that additional ground water monitoring is appropriate. Plans for additional monitoring would be provided to the Government Plaintiffs for review and approval.

Quarterly sampling and analysis will be conducted for each of the interception system monitoring wells, for the four indicator compounds shown in Table V-1 and discussed in Section

V.A.2a, except the performance monitoring wells (sets A and B) will initially be sampled more frequently as subsequently described in Section V.C.2b. Quarterly sampling for each well will be continued until no exceedance of the Table V-1 adjustment control criteria is identified for twelve consecutive quarters. In the event that, for a particular well, no exceedances occur during the twelve quarters, sampling will be reduced to an annual frequency for the next two years. If no exceedances have been identified during this five-year period, the County will determine whether continued monitoring is appropriate based on the need to assure longer-term protection of purveyor wells near the site. If no exceedances occur in a particular monitoring well (or converted extraction well, as described in Section V.C.2b), but an increasing trend in concentrations is identified that would likely result in exceedance of the adjustment control criteria, the County will implement a longer-term sampling and analysis program that assures the protection of human health and the environment.

In the event that a single exceedance of the adjustment control criteria occurs, a follow-up sampling will be accomplished. An exceedance will be confirmed if concentrations exceeding the adjustment control criteria specified in Table V-1 are identified in three consecutive samples collected at two-week intervals. If an exceedance is confirmed, the Government Plaintiffs may require installation of additional monitoring wells or implementation of more extensive monitoring of existing wells. Further, the County will submit, for the Government Plaintiffs' review and approval, a program to address the exceedance. This program will include measures to protect human health and the environment.

The criteria presented in this section (V.C.2a) applies only to monitoring during system operation. While the interception system is shut off and on standby status, this system operation criteria is superseded by the monitoring criteria described in Section X of this Scope of Work.

b. Interception System -- In order to meet the goals identified in Section V.A.1a, the County will accomplish the following:

- Conduct the Phase I pilot studies to obtain the needed aquifer characteristics for designing an interception system.
- Complete a preliminary design engineering report detailing the most probable aquifer characteristics, design parameters and project costs. The system will be designed utilizing capture zone analysis to achieve overlapping cones of depression, and such that the total pumping capability of the interception well system is sufficient to intercept the plume to the extent described in this section. Selection of pumping test methodologies and capture zone analysis will be subject to the review and approval of the Government Plaintiffs.

These extraction wells will be installed east of Highway 2 in proximity to the north-south alignment shown in the ROD. Extraction wells will be installed in succession from the center to the outermost limits of the plume. The spacing of the wells will be determined by the County based on hydrogeologic and chemical data. Extraction wells will be installed until the ground water at the outermost limits of the system is below the adjustment control criteria. The outermost wells will be used for interception system monitoring and will be constructed such that conversion to extraction wells is possible if exceedances of adjustment control criteria are subsequently identified. If an outboard monitoring well is converted to an extraction well, an additional monitoring well (constructed for possible conversion to an extraction well) will be constructed to the outside of the converted monitoring/extraction well.

Interception system design criteria will be based on the Table I-1 Performance Standards. Operational and adjustment criteria will be developed based on Table IV-1 evaluation criteria and observed interception system efficiency during the early stages of Phase II.

The design criteria will serve as a guide for the use of the capture analysis referred to in this section. The basis for design of that portion of the west system that intercepts ground water migrating into the capture zone(s) of existing downgradient supply wells will be that the average concentrations of the constituents of concern in the existing supply wells downgradient of the interception system are predicted to be no greater than 15 percent of the Table I-1 Performance Standards based on capture zone analysis. The remainder of the system will be designed such that the average concentrations of constituents of concern in the lower aquifer downgradient of the interception system will be no greater than 50 percent of the Table I-1 Performance Standards.

Commencing at a mutually agreed-upon time following startup of the interception system, the two sets (A and B) of downgradient performance monitoring wells will be sampled monthly (for Table V-1 constituents) for two years, or some other mutually agreed-upon length of time. Based on statistical analysis of the chemical data from these wells, separate baseline concentrations⁽³⁾ will be identified for each set (A and B) of downgradient performance monitoring wells for each Table V-1 constituent. The baseline concentrations for each set (A and B) of monitoring wells will be equal to the average of the time-averaged concentrations in the

(3) If the resulting concentration is below the Practical Quantitation Limit (PQL) for a Table I-1 constituent, the PQL reported for EPA Method 8010 (USEPA, "Test Methods for Evaluating Solid Waste," SW-846, 3rd Ed. 1986) will be used as the baseline concentration for that constituent.

three performance monitoring wells associated with that set and, if appropriate, may include vertical averaging for nested wells or well clusters, after the data associated with the expected gradual changes following startup are eliminated.

Operational control criteria for the west interception system will be developed for the appropriate Table V-1 indicator compounds (1,1-TCA and 1,1-DCA) and will only apply to that portion of the system intercepting ground water migrating towards existing downgradient supply well capture zones and will be equal to the lesser of: 1) the baseline concentration based on the "A" set of monitoring wells plus 15 percent of the Table IV-1 evaluation criteria or 2) 30 percent of the Table IV-1 evaluation criteria. If, after confirmation (as defined in Section V.A.2a) the average concentration in the "A" set of performance monitoring wells exceeds the operational control criteria, the County will re-evaluate the operation of the interception system. Should this re-evaluation indicate adjustments to the system are appropriate, the County will submit a proposal for interception system adjustment to the Government Plaintiffs for review and approval. Adjustments may include increasing pumping rates (for one or more wells), or other adjustments to the existing system considered appropriate for improving contaminant interception efficiency.

Adjustment control criteria for the west interception system will be developed for the Table V-1 indicator compounds and will be equal to the lesser of: 1) the baseline concentration (for set "A" or "B" monitoring wells", as appropriate) plus 50 percent of the Table IV-1 evaluation criteria or 2) 65 percent of the Table IV-1 evaluation criteria.

If after confirmation (as defined in Section V.A.2a), the average concentration in either the "A" or "B" sets of downgradient monitoring wells exceeds the adjustment control criteria for two consecutive quarters (or some other mutually agreed upon timeframe that will better allow reflection of system adjustments in downgradient monitoring wells) following system adjustment (as described previously for operational control criteria exceedances), the interception system will be modified if applicable. Additionally, the interception system will be modified if any Set "A" individual downgradient performance monitoring well exceeds the Table IV-1 evaluation criteria for two consecutive quarters (or other time period, as described above). Modifications may include increasing pumping rates (for one or more wells), adding extraction wells to the system, or other methods of correcting interception system deficiencies. The County will submit a proposal for interception system modification to the Government Plaintiffs for review and approval.

In addition to the operation and adjustment control criteria described above, should any set "A" downgradient performance monitoring well, following the development of baseline concentrations, exhibit anomalous concentrations or trends in concentrations inconsistent with effective interception system performance (such as an increasing trend in concentration projected to lead to a long-term exceedance of the Table V-1 adjustment control criteria), the County will evaluate the operation of the interception system. This evaluation will address the potential cause(s) of the anomaly and possible system adjustments or modifications (if appropriate), and will be presented to the Government Plaintiffs in a written report for their review within 60 days of the evaluation.

If it is determined by the County that an exceedance of the above criteria is the result of supply well interference with the interception system, adjustment to, or modification to, the system may include elimination of the interference. Elimination of the interference may require either partial or complete cessation of supply well use. The County will attempt to negotiate a settlement with the well owner. If an equitable agreement cannot be reached between the County and the well owner, the Government Plaintiffs will use their statutory authority to seek termination of usage for the interfering well.

Based on cost effectiveness or a determination by the County that acceleration of the cleanup is appropriate, the County may, at its discretion, propose additional upgradient extraction wells. Any such proposal will be submitted to the Government Plaintiffs for review and approval.

If ground water withdrawn by an extraction well meets the operational control criteria for two consecutive quarterly samplings, water from this well will not require treatment prior to discharge. If a subsequently confirmed exceedance of the operational control criteria is identified, treatment of water from the extraction well will be resumed.

Operation of an extraction well may be discontinued if ground water at that well meets the adjustment control criteria. If shutdown of the well thereby occurs, the well will be sampled as described above in Section V.C.2a for monitoring wells. If a subsequently confirmed exceedance, or an identified trend of increasing chemical concentrations occurs that can be projected to lead to an exceedance, of the adjustment control criteria at downgradient supply wells, reactivation of the extraction well may be necessary.

If concentrations in ground water entering an extraction well decrease (confirmed as described in Section V.B.2a for exceedances) to levels below the Table IV-1 evaluation criteria, pulse pumping may be initiated at the discretion of the County. Procedures for pulse pumping,

which are protective of human health and the environment, will be provided to the Government Plaintiffs for review and approval.

c. Treatment System -- A water treatment system utilizing air stripping, designed to treat water to comply with the Performance Standards, will be installed. The treatment system design will use data developed during the Phase I pilot program.

If water discharged from the treatment system exceeds the Table IV-1 evaluation criteria, necessary improvements or operational adjustments will be accomplished by the County after review and approval by the Government Plaintiffs. In the event that the treatment system cannot meet the Table IV-1 evaluation criteria for methylene chloride, the Government Plaintiffs may apply less stringent evaluation criteria for this constituent. Indicated exceedances will be confirmed using the same methodology described for monitoring wells in Section V.C.2a.

A gravity air stripping system, which takes advantage of the elevation drop between the bluff near Highway 2 and the Little Spokane River may be installed, if Phase I pilot system test results indicate this method will meet Table IV-1 evaluation criteria. If, based on the criteria identified in Section V.D., off-gas treatment is required, a conventional air stripping system will be installed.

d. Discharge -- Disposal of treated water will be to the Little Spokane River. Discharge water will meet the Table IV-1 evaluation criteria. Plans for the discharge system will be submitted to the Government Plaintiffs for review and approval.

D. Air Emissions Abatement

The necessity for air stripping tower off-gas abatement during Phase II will be evaluated based on the assessment of lifetime cancer risk for carcinogenic compounds, and on hazard indices for non-carcinogenic compounds, in accordance with methods described in the Superfund Public Health Evaluation Manual (EPA 54011-86/060, 1986). Phase I data, and the criteria described below, will be used in these evaluations during Phase I. Additional data developed during the early stages of Phase II will be used to reassess the Phase I evaluation. If the County can demonstrate to the Government Plaintiffs that the lifetime cancer risks and the hazard indices are below 10^{-6} and 1, respectively, off-gas treatment will not be required.

A preliminary analysis of air emissions for the Table I-1 compounds has been accomplished using a standard Gaussian plume model and 100 percent transfer efficiency (water to air media). The analysis considered receptor distances of 500 and 1000 feet, a stack height of 40 feet, and assumed that all water treatment would be accomplished at one location. The

analysis used National Weather Service Wind Data for the Spokane International Airport and an initial mass flux to the stripping towers equal to that arrived at from the projected influent concentrations and pumping rates identified in the RI/FS. It was further assumed that the total mass of each constituent removed during the cleanup could be equal to as much as 5 times the mass of each constituent identified as being present in the ground water, based on the data contained in the RI/FS.

Based on these assumptions, the model predicts that for the carcinogenic and potential carcinogenic compounds (TCE, DCE, PCE, and MC) the summation of the incremental increases in cancer risk for the individual compounds is below 10^{-6} (1 in 1 million), and the hazard index summation for all Table I-1 non-carcinogenic compounds is below 1. Because the analysis utilized some assumptions which have not been fully confirmed at the site, the following verification steps will be taken:

1. Air monitoring and modeling will be conducted during Phase I to confirm the wind speed, wind direction, and applicability of the Gaussian model. If the County determines that air emissions can be better analyzed using a different model, the proposed model, and rationale for its use, will be submitted to the Government Plaintiffs for review and approval.

2. Phase I and Phase II data will be evaluated to estimate the total mass of the six indicator constituents present in the ground water.

3. Measurements will be made during Phase I and the early stages of Phase II to identify the mass flux of the six indicator constituents to the stripping tower(s). These data will be compared with the flux rates identified in the RI/FS.

If the new information supports the initial analysis, air stripping tower off-gas abatement will not be required.

If the Phase I data does not support the initial analysis, the County will re-examine the need for Phase II off-gas treatment. This re-examination will be accomplished prior to Phase II and presented to the Government Plaintiffs for their review and approval. Should this re-examination identify that off-gas treatment is necessary on either a temporary or permanent basis, based on the criteria described above, the County will make the appropriate adjustments to incorporate carbon absorption, or some other agreed-upon method of air emissions abatement, in the stripping tower design for Phase II.

Air emissions abatement will be re-evaluated during the early stages of Phase II (within a year of Phase II startup). If the Phase II data do not support the Phase I analysis, the County will re-examine the need for off-gas treatment within 60 days of re-evaluation and submit such

re-examination to the Government Plaintiffs for review and approval. Should this re-examination identify that off-gas treatment is necessary on either a temporary or permanent basis, based on the criteria described above, the County will retrofit the stripping tower(s) with carbon absorption, or some other agreed-upon method of air emissions abatement. Alternately, should this re-examination identify that off-gas treatment is no longer necessary (if required following Phase I analysis), off-gas treatment may be terminated.

Well Construction Variance Request and Approval



LANDAU
ASSOCIATES.
INC.

Geoenvironmental Engineering and Technologies

November 21, 1989

Mr. Dan Weis
Washington State Department of Ecology
North 4601 Monroe, Suite 100
Spokane, WA 99205-1295

RE: MONITORING WELL CONSTRUCTION
COLBERT SUPERFUND SITE

Dear Mr. Weis:

Landau Associates, Inc. (Spokane County's consultant for the Colbert Landfill Superfund project) is requesting a variance to the Well Construction Regulations (WAC 173-160) to permit construction of a 2.5-inch (nominal) inside diameter monitoring well inside a 6-inch diameter welded steel casing, as discussed during your November 16, 1989 telephone conversation with Mr. Brian Butler. The opportunity to use 6-inch welded casing during the construction of some monitoring wells would allow the project greater flexibility in the use of available materials while maintaining high standards of monitoring well construction.

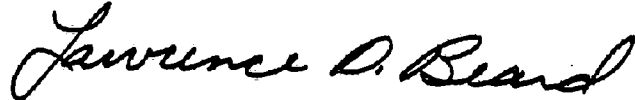
The monitoring well regulations (WAC 173-160-540) require that the borehole diameter be 4 inches larger than the nominal (outside) diameter of the well pipe. The requested construction would result in 3.75 inches of clearance between the 6.625-inch OD borehole and the 2.875-inch OD well pipe. Construction methods approved for the Colbert site construction include: 1) using stainless steel centralizers in the vicinity of the screen to provide a uniform annulus of sand pack material, and 2) installing a high-solids bentonite grout annular seal tremied in place using a 1.5-inch pipe. Based on our experience gained during installation of the seven monitoring wells thus far completed during the project, we feel that a 3.75-inch clearance will permit high quality monitoring well construction to continue. As discussed on November 16, 1989, if problems are encountered as a result of using 6-inch welded steel casing to construct 2.5-inch monitoring wells, its use will be discontinued. A diagram reflecting monitoring well construction methods previously approved for this site is attached for your information.

This request has been discussed with, and favorably received by Mr. Mike Blum, the Washington State Department of Ecology Project Manager for the Colbert Landfill Superfund project. Please call me (509/328-3371) or Mr. Blum if you have any questions, or when you have made a decision regarding this variance request.

Very truly yours,

LANDAU ASSOCIATES, INC.

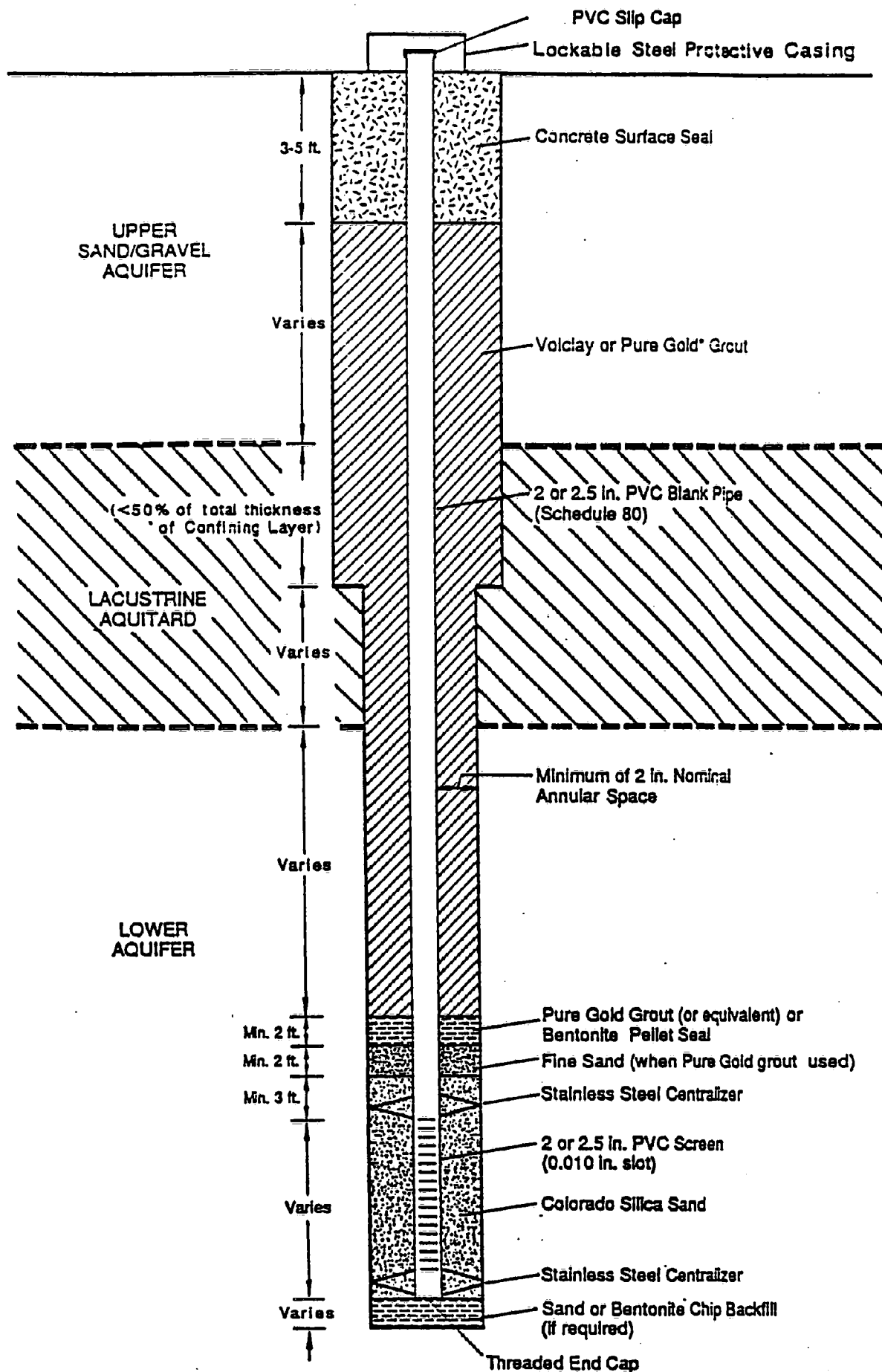
By:



Lawrence D. Beard
Project Manager

LDB/BFB:sg
No. 124-01.30
attachment

cc: Mr. Bill Miller, Ecology (Administrator, Well Drilling Program)
Mr. Mike Blum, Ecology (Colbert Landfill Superfund Cleanup, Project Manager)



LANDAU ASSOCIATES, INC.

Typical Monitoring Well Design
Lower Aquifer

GM-2-21

Figure GM-2.4

CHRISTINE O. GREGOIRE
Director



STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

N. 4601 Monroe, Suite 100 • Spokane, Washington 99205-1295 • (509) 456-2926

November 28, 1989

Mr. Lawrence D. Beard
Landau Associates, Inc.
P. O. Box 1029
Edmonds, WA 98020-1029

Re: Request for Variance to Well Construction Standards

Dear Mr. Beard:

Pursuant to your request for a variance to well construction standards Chapter 173-160 WAC.

The well construction standards require that within unconsolidated formations an annular space of four inches greater than the diameter of the nominal size of the intended permanent casing is required.

Your proposal would result in an annulus of 3.75 inches between 6.625 inch OD borehole and the 2.875 inch OD well pipe. You would continue to use stainless steel centralizers in the vicinity of the screen to provide a uniform annulus of sand pack material, and installation of high-solids bentonite grout seal.

This variance is granted provided that no construction problems are encountered as a result of the smaller annulus.

The department shall not be liable for any failed well construction as a result of the granting of this variance.

Sincerely,

A handwritten signature in cursive script, appearing to read "Dan Weis".

Dan Weis
Water Resource Program

DW:aal

cc: Bill Miller/WDOE/Olympia
Mike Blum/WDOE/Olympia